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FurnaceDoctor®-Pro
V2.0

USER MANUAL

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****CAUTION****

DO NOT CLOSE CHARGER IN LID

SCREEN CAN BE DAMAGED

NOT COVERED BY WARRANTY

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SAFETY

Please read the instructions before operating the instrument.

This instrument complies with accepted industrial safety standards.
Do NOT operate this instrument with the internal top cover removed.

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EQUIPMENT RATINGS

Supply Voltage	110-240 VAC
Supply Frequency	50/60 Hz
Power Consumption	3.2/1.8 Amps
Certifications/Compliance	CE

	Range	Resolution	Accuracy
CO	0-30 %, 0 – 45%	0.02 %	2% of range
CO2	0-2%	20 ppm	1% of range
CH4	0-10%	0.02 %	2% of range

Operating Temperature	40°F - 120°F
Relative Humidity	5% - 90% non-condensing

Atmospheres:

Suitable for:

Carburizing
Carbonitriding
Carbon Correction
Neutral Hardening
Austempering
Martempering
Precipitation Hardening
Annealing
Normalizing
Stress – Relieving
call FCC if your process is not listed

NH_3 (ammonia) is strictly prohibited in the sample
-NH3 filters available upon request-

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THEORY

Why Infrared?

By purchasing your new FurnaceDoctor®-Pro, you have obviously made the decision that your current process measurement methods require some enhancement. This may be due to customer requirements for back-up process verification to your existing oxygen probe based system or simply a matter of answering the question “is that probe really working?” You might be looking for more complete information of what is happening with respect to your furnace atmosphere.

Whatever your reasons, the use of I/R analysis, and the FurnaceDoctor®-Pro will satisfy these requirements.

Since most FurnaceDoctor®-Pro owners are either performing gas carburizing, or neutral hardening in an endothermic atmosphere, the following discussion will help to understand the meaning of the measured values:

Endothermic atmospheres in use for these applications have this basic composition:

$CO \cong 20\%$	(carbon monoxide)
$H_2 \cong 40\%$	(Hydrogen)
$CO_2 \cong$ Trace	(carbon dioxide)
$CH_4 \cong$ Trace	(methane, usually from natural gas)
$O_2 \cong$ Trace	(oxygen)
$H_2O \cong$ Trace	(water vapor)
N_2 .Balance	(nitrogen)

These ratios are typical whether you are producing gas by means of an endothermic generator, or using prepared gasses such as nitrogen and methanol. Ratios are slightly different if propane is used rather than methane for the production of carrier gas.

Obviously any increase in volume in one of the gasses means a decrease in one or more of the other gasses. We often get asked the question “Why is my generator producing 20% CO, but I am only measuring 17% at my furnace?” “It is even lower when I add ammonia!” One part of the answer to

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this question is simple volumetric displacement. There is only room in the furnace for 100% of the atmosphere!

How can the FurnaceDoctor®-Pro help me with my generator?

The basic chemical reaction taking place in an endothermic generator is as follows:

$$2CH_4 + O_2 \rightarrow 2\ CO + 4\ H_2$$

Ignoring the nitrogen

Remember you are mixing gas and air together and heating it up to produce the above described gas composition. The reaction takes place in two stages: First some of the methane burns with air and makes heat. The by-products of this combustion are H_2O (water vapor), and CO_2. In the second stage, the remaining methane reacts with the CO_2, and H_2O. It becomes obvious that we want this reaction to be as complete as possible!

This is the reason for the nickel catalyst in the generator.

Assuming that the main air gas ratio is set somewhere between 2.7 and 2.85 parts air to 1 part gas, there are two considerations:

1. The catalyst must be clean, and free from soot. If soot is present, the efficiency of the above reactions goes down.

2. You must have adequate temperature to keep the rate of the reactions high enough.

So how can the FurnaceDoctor®-Pro help?

First by measuring the generator's methane content you can determine whether or not the catalyst is operating efficiently. .8% CH_4 is about the upper limit. Above this level it is possible that the catalyst is laden with soot, or the catalyst is simply spent. Another indication of this condition would be a high CO_2, or dew point. The FurnaceDoctor®-Pro provides a convenient way to obtain dew point, CO, CO_2, and CH_4.

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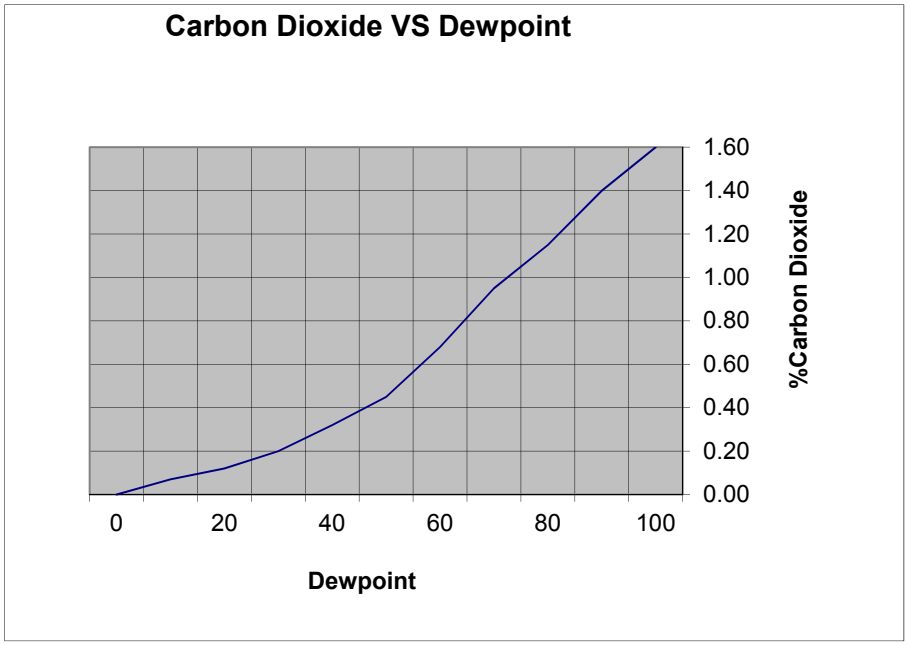
Check to see that the basic gas composition is as expected. CO should be around 20%. Check the CH_4 level and be sure that it is less than .8%, observe the CO_2, and the dew point readings. Note the relationship between dew point, and CO_2.



Make adjustments to either your oxygen probe control system, or the generator carburetor to obtain the desired dew point.

How will the FurnaceDoctor®-Pro help me with my Furnace atmosphere?

If you are using oxygen probes the FurnaceDoctor®-Pro can supply independent, traceable verification of your probes accuracy. It will also give you a much more complete picture of what is happening in your furnace atmosphere.

The primary reactions involved in carbon transfer are well understood as:

$$2CO \rightarrow C\gamma + CO_2$$
$$H_2 + CO \rightarrow C\gamma + H_2O$$

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These reactions are assumed to be close to equilibrium. The theory behind this is that a reaction sometimes called the water-gas reaction, is busy keeping the H_2 and O_2 in balance:

$$CO + H_2O \leftrightarrow CO_2 + H_2$$

The measurement of %Carbon in your atmosphere with an oxygen probe is based on the assumption that the above is true:

$$CO \rightarrow C\gamma + \tfrac{1}{2} O_2$$

Note that it is assumed that the primary mechanism of carbon transfer is CO dependant. What is really happening is that the ratio of CO to CO_2 is much more accurate means of determining equilibrium carbon.

One problem is that we use CH_4 as enriching gas. What happens to the CH_4 once it enters the furnace? It decomposes - mostly near the hot catalytic surfaces in your furnace.
It may be replenishing depleted CO, based on equilibrium “rules” it may be making soot crumbs on your hearth, or it may be reacting directly with the surface of the material:

$$CH_4 \rightarrow C\gamma + 2H_2$$

How much of the above reaction is happening is dependent on how much methane is present in your furnace. The reaction also happens faster at higher temperatures, but is still slow compared to the equilibrium reactions.

For example at 1600 with an equilibrium carbon potential of .4%, and methane content of .5 the theoretical carbon potential is actually .44%. In reality the effect is usually about 6/10 of what the theoretical calculations deliver making the carbon potential closer to .42%. By contrast if we were to up the methane content to 5%, the actual carbon potential might be closer to .6%, a significant difference!

Whether the work really ends up seeing this is dependent on a number of issues - temperature – governing the rate of reaction, the surface area of the work and the level of saturation at the surface, atmosphere circulation, etc.

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Using the FurnaceDoctor®-Pro to analyze furnace atmosphere

Probe condition:

Carbon is computed using actual gas values, so it is more accurate than the assumptions made by the probe. Compare the %C calculated by the FurnaceDoctor®-Pro to %C displayed on the Carbon Control instrument.

Your carbon controller is set up with some assumptions about the content of the furnace atmosphere. Most controllers assume a CO to be 20% “out of the box” you may use the FurnaceDoctor®-Pro to correct this situation by adjusting this “factor” to the correct %CO.

Observe the probe millivolts as computed by the FurnaceDoctor®-Pro, and displayed by the carbon controller. These should be within 1-2 % of each other. If not, and you have entered the process temperature into the FurnaceDoctor®-Pro correctly, you probably have a problem with the probe or the controller. First check the millivolt reading at the back of the probe with a meter to eliminate any possible instrument problems.

Next be sure that the probe is free of soot by burning the probe off. If the numbers still do not agree, perform an impedance test on the probe to help determine the electrode condition. You will also want to check to see how fast the probe recovers after this test. Recovery time should be in seconds, not minutes.

Finally disconnect the probes reference air tube, and see if the millivolts reading on the controller changes, if it does you have a leak in the probe substrate.

If you change the probe or if you are sure that the probe is ok, check to be sure you are obtaining a good sample at the FurnaceDoctor®-Pro. Many times sample ports are the cause of the problem. A good non-metallic sample probe helps solve this. One trick is to use the probe burnoff port to obtain a sample. This has a few problems associated with it in furnaces running high methane contents. The methane will crack near the alloy

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surface of the probe creating a local reaction not representative of the overall furnace atmosphere.

Interpreting the gas value readings:

CO: For most atmospheres in use this number should be around 18-20%. If it is lower than 18% then observe the following:

Check generator for proper operation.
If you are using nitrogen methanol, check the ratio of nitrogen to methanol. Also be sure that the atmosphere sparger is in good condition. If you are using nitrogen to “push” the methanol into the furnace be sure that the methanol is not getting nitrogen bubbles in it.
If you are using ammonia, the ammonia additions will dilute the %CO in the furnace. Remember there is only room for 100% of the gas in the furnace
Check for leaks. This can be confirmed by a high CO_2.
If you are asking for a high carbon potential, high methane content, may also dilute atmosphere mix.
Check for leaks. Air leaks typically cause the control system to add more natural gas to the furnace.
High surface area loads will be able to draw more carbon out of the atmosphere. Typically the methane content will go up because of this.

CO_2: This number can be anywhere between .05% to 1% and is dependent on temperature, and gas composition. It tracks inversely to carbon potential. At 1600F a .4%C will be about 0.62% CO_2 (assuming 20% CO). To achieve a .4% carbon at 1750 CO_2 will be around .25

If the carbon potential is lower than expected the CO_2 should be higher than expected.
Check for air leaks.
Check for burner tube leaks.
Check for furnace fan water jacket leaks.
Check generator or nitrogen methanol system.
If the probe system is in agreement with the FurnaceDoctor®-Pro, be sure there is adequate carrier gas flow, and adequate enriching gas flow.

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Is carbon controller turning on the natural gas when it should?

CH_4: Most batch furnaces will operate with a CH_4 content ranging from .1% to 4-5%. At the start of the cycle this number is higher than when the atmosphere and the work approach equilibrium with each other. Continuous furnaces performing carburizing will usually operate at higher methane levels. In fact in some belt furnace applications this is necessary for the process to work!

High free methane content is usually a product of the control system calling for too much natural gas due to an air leak, unusually high surface area in the load.
Check for air leaks.
Check for burner tube leaks.
Check for furnace fan water jacket leaks.
Check generator or nitrogen methanol system
Be sure that the probe control system is working properly

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OPERATIONS

Precautions before operations:

1) Dew point of sampling gas must be lower than the ambient temperature to avoid occurrence of drain in the gas analyzer. If vapor is contained in the sampling gas, dew point should be lowered to 0°C by using a dehumidifier
2) Temperature of sampling gas should be within 0 to 50°C. Provide a means that prevents entry of hot gas directly into the instrument
3) Absolute pressure of sampling gas should be 926 – 1024 mb. Avoid flow or pressure fluctuation during measurement. Observe the flow reading by a flow meter provided
4) Avoid installing this instrument near an electrical unit (high frequency furnace or electric welder) that generates much electrical noise
5) Allow 20 minutes warm-up for stabilized readings.

SAMPLE GAS

The condition of the sample must conform to the following requirements to ensure that the performance of the product meets the stated technical specification. Contamination in the sample cell, particularly on the windows, will cause an error in the output reading

Avoid degradation of the sample gas between sample point and the sensor by the introduction of unnecessary volumes or restrictions.

Eliminate transients which can cause pressure variations.

Maintain constant flow conditions.

Avoid the use of rubber compounds for the sample tubing (adsorption effects).

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Particles:
The gas to be measured must be well filtered. 100 % of 3 μm particles must be retained.

Humidity:
Prior to entry in the FDPRO, the moisture in the gas must be adequately reduced. This means that the dew point of the gas must be brought below the operating temperature of the FDPRO by some means. No moisture can then condense in the ACCUBENCH.

Liquids
The sample gas must be free of any liquid

Entrained oil
The sample gas must be free of any contamination.

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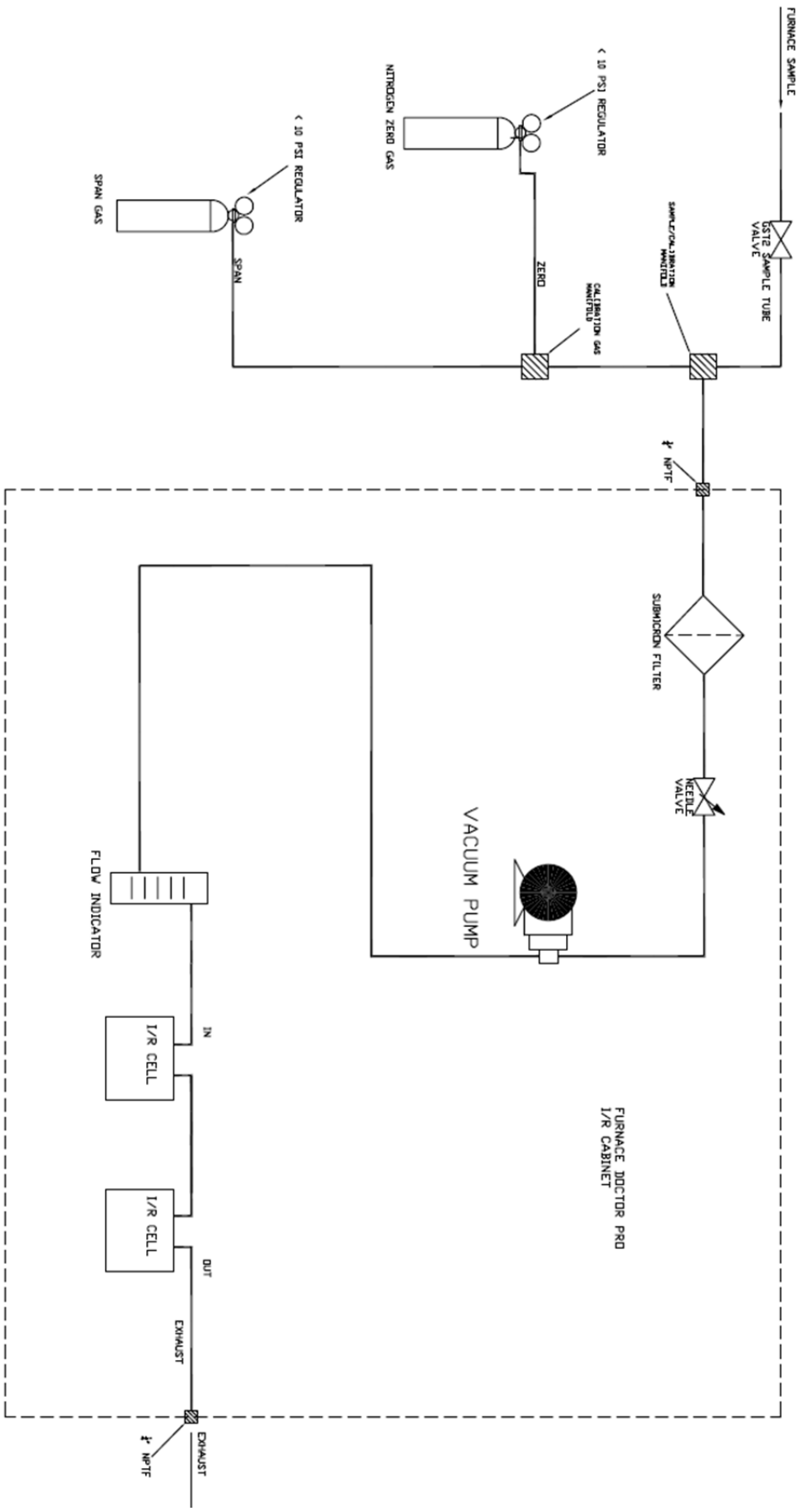

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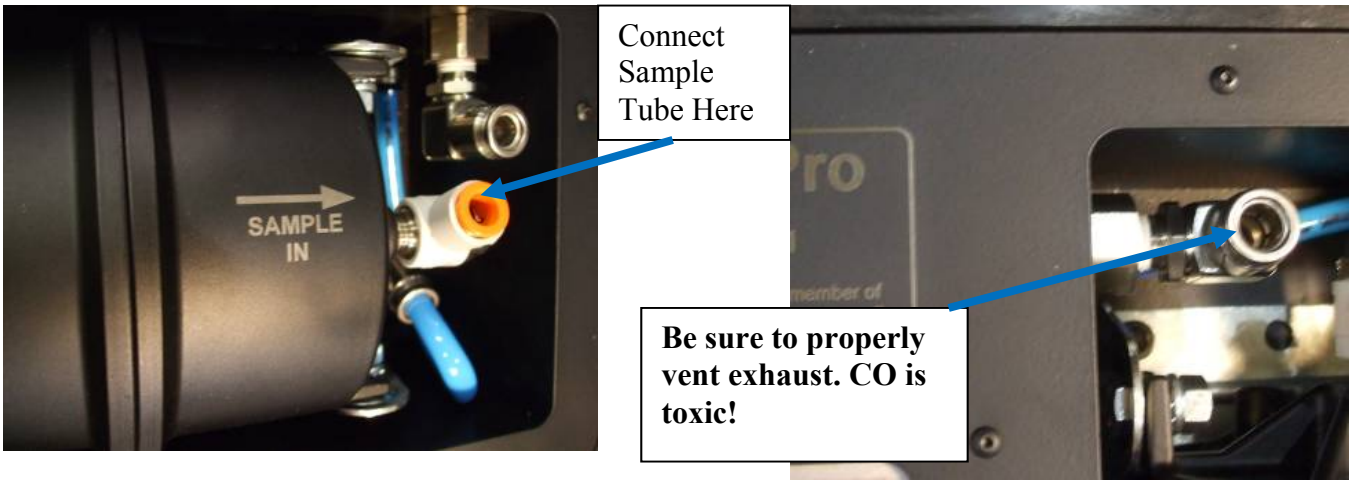
Connect one end of the sample tube to the inlet. Connect the other end to the furnace sample port. Do not connect to a port with a lamb's wool, or angel hair filter already installed. Be sure to properly vent exhaust!

We strongly recommend a small diameter (½" id or less), non-metallic sample tube that can be inserted at least 2" past the refractory wall hot face to ensure an accurate sample.



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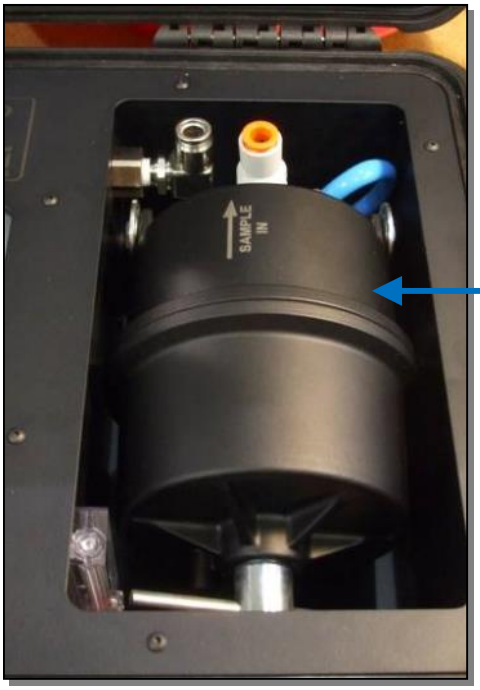
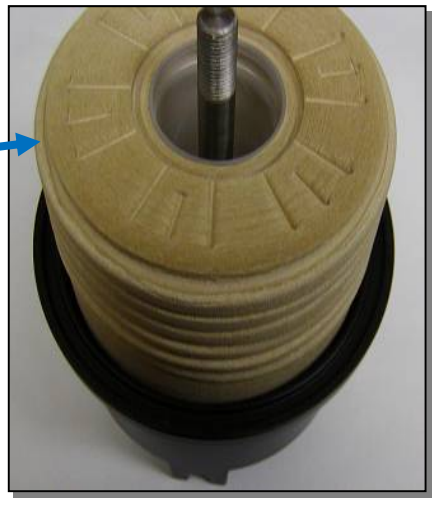
Rotate Handel CCW and remove cover.



Lift Filter to upright position (take note of O-ring and insure it is properly seated at all times)

Be sure that the filter is clean, and free from moisture!
Soot build-up or discoloration in the sample element requires the element to be replaced.

* Caution * - re-insert the filter element with the same orientation or risk damaging the FDPRO by introducing contaminants into the gas stream



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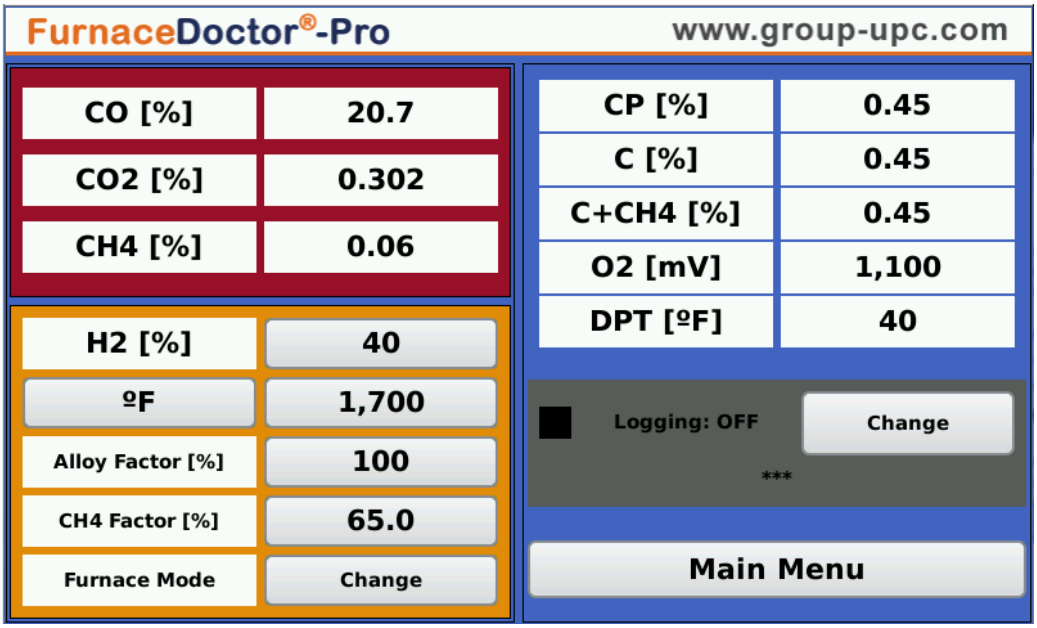
Turn on the power switch. Depress the Pump button to start sampling. Your FurnaceDoctor®-Pro is equipped with a battery monitor. When a battery level monitor is low, it is time to charge your FurnaceDoctor®-Pro.

The LCD display will illuminate, and the internal pump will start after pump button is depressed. Manually input fields are in grey, live and calculated fields are in white. Buttons are grey.



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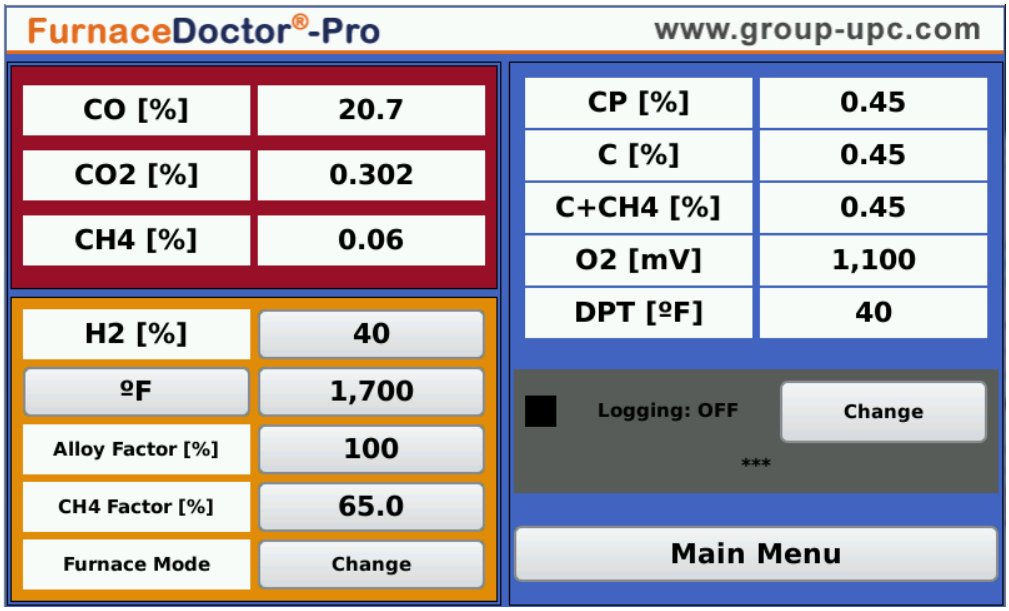
After 30 seconds gas values will be measured and displayed.



Ensure that sample flow is adequate. If you are sampling a generator keep the flow rate below 9 SCFH so you do not compress the gas - leading to an incorrect reading.

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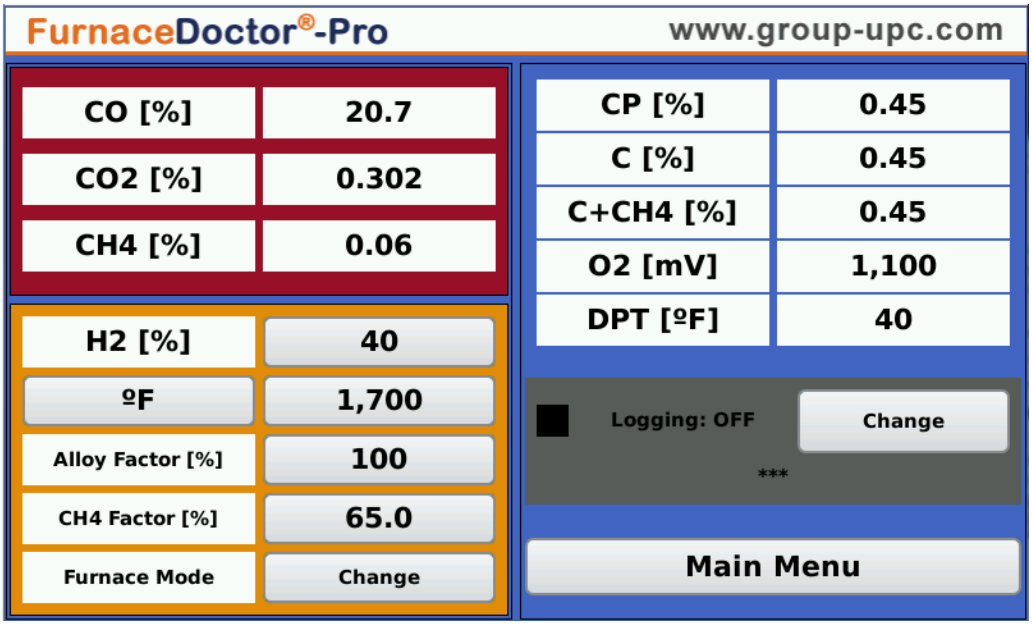
A note about sample ports:

In a large percentage of heat treating environments, we have found that the furnace sample ports are either plugged, or leaking. Even if you can look into the port, and it appears unobstructed, the port may leak somewhere behind the hot face of the refractory. This may cause the sample to be drawn from between the brick, and the furnace shell, or even outside of the furnace. It is also necessary to keep the sample velocity high in order to quickly stabilize the CO2

For this reason we strongly recommend the use of a non-metallic sample probe that will penetrate the furnace wall at least 2” past the hot face of the refractory.

If you are unable to use a non-metallic probe and if you are getting numbers that just do not make sense (I.E. Extremely low CO values or high CO_2) then try taking a sample from the oxygen probe burn-off port (not the reference airport). ***Only use this method if no other working port is available. This method will affect the probe reading.***

The following display is shown on the LCD when power is applied to the unit.



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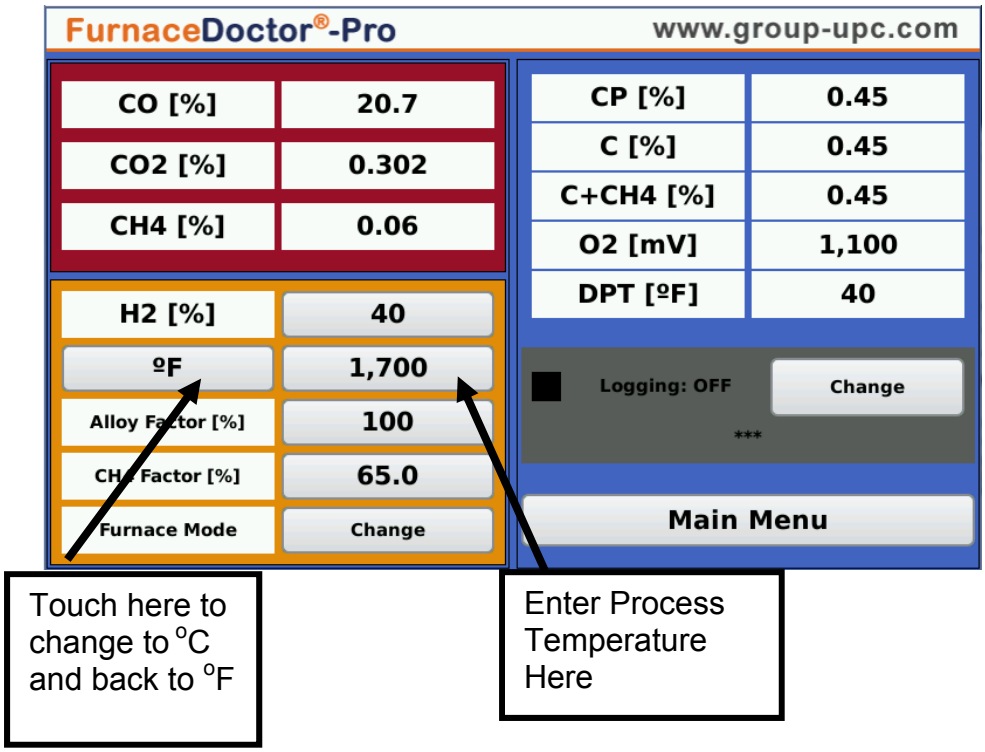
Measurement begins approximately 1 min after start up and is continuous after the process temperature is entered. The unit will not correctly display O_2 mV, Carbon, or Dewpoint until temperature is entered. The display includes actual CO, CO_2, CH_4 as readings, calculated theoretical carbon and dewpoint and milli-volts for the computed %Carbon and manually entered temperature.

To compute the correct %C associated with the CO, CO_2, and CH4 measured gasses you must enter the process temperature.



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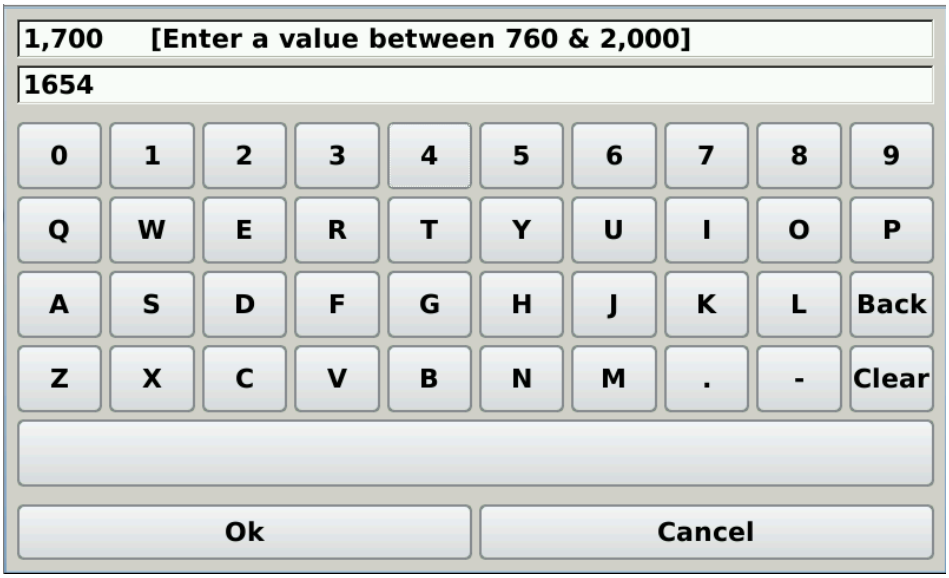
Touch the temperature field and a numeric key pad will appear. Enter the process temperature and press the OK button.



The instrument displays the carbon, dewpoint for the measured CO, CO_2, CH_4 gasses and entered probe temperature. Additionally, it displays calculated probe millivolts. Calculated prove mV uses an algorithm that assumes CH4 is equal to zero.

The instrument will take at least 60 seconds from cold start to display any meaningful information. Ensure that sample flow is adequate! It's always a good idea to allow at least 3 minutes of operation to obtain a meaningful reading.

The FurnaceDoctor®-Pro can be switched between Deg F and Deg C by touching the ^{o}F / ^{o}C box

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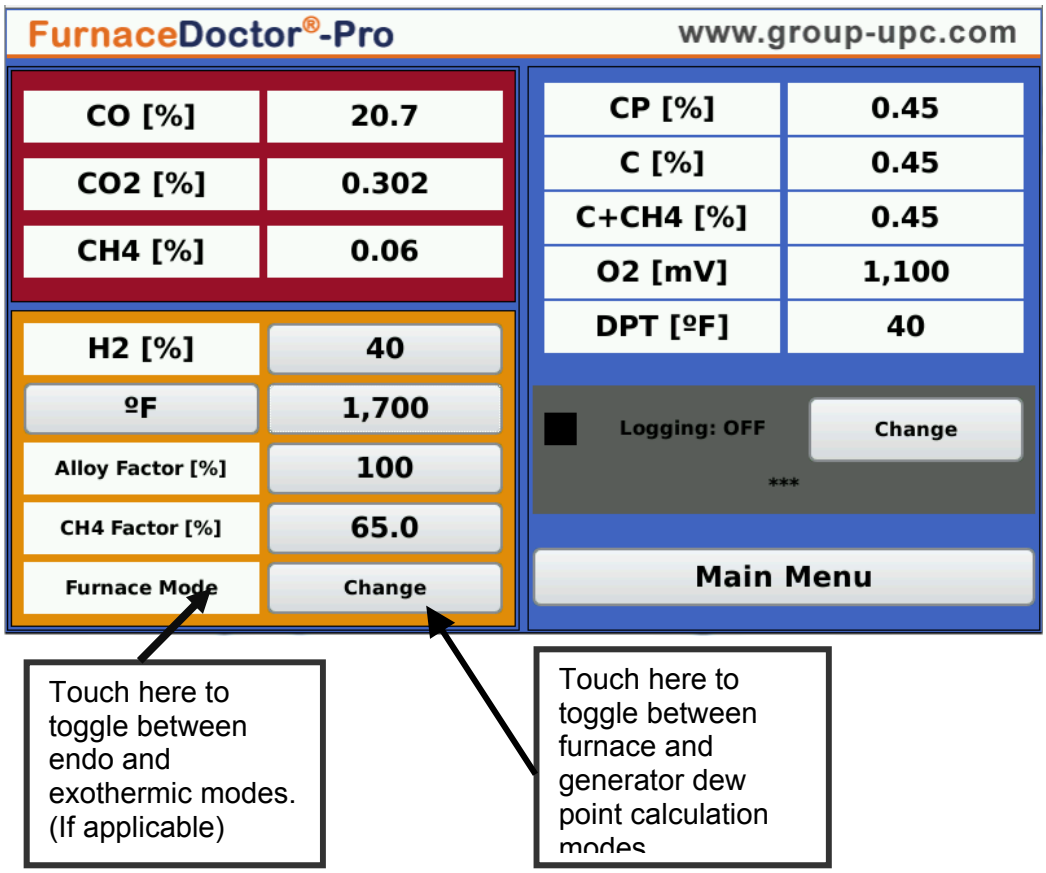
Selecting the Dew point, Calculation Modes:

The instrument will compute dew point using either a temperature based calculation, used when measuring furnace atmospheres where you can identify the process temperature or a simplified table look up method based on CO_2 to be used when measuring the dew point of endothermic generators.

If you use the furnace calculation when measuring your endothermic generator, and enter a process temperature of 1900F or so, you will get meaningless values for dew point.

If you have the generator calculation selected, it is not necessary to enter a process temperature. You must select the correct carrier gas from the *Configure I/R Screen.* From this screen you can select the correct carrier gas for you process



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Touch the *Change* button next to the *Furnace DPT mode* text and the instrument will toggle to Gen Dpt Mode.
Touch the button again to return to the furnace dew point mode, same for Endo and Exothermic modes (if applicable)

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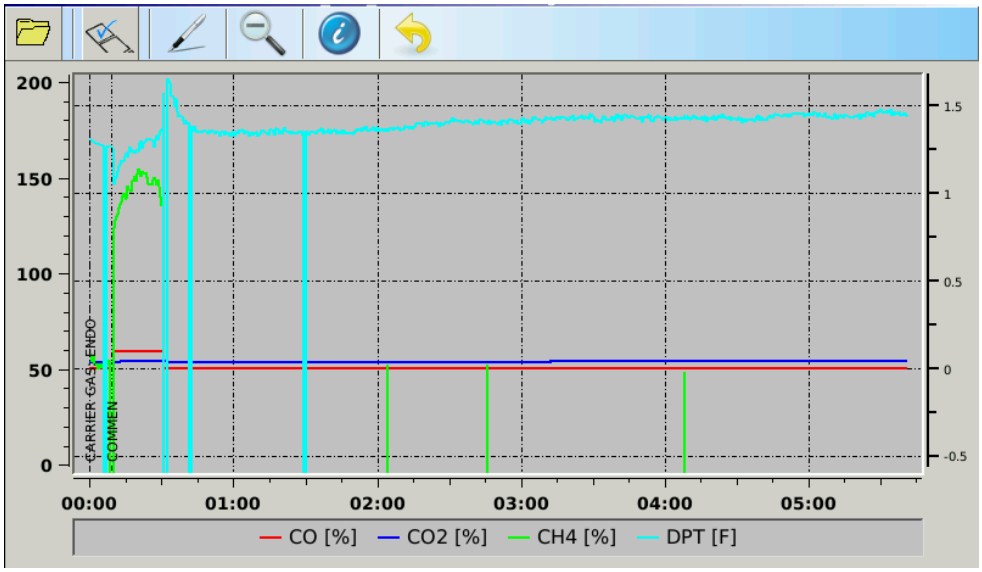
DATA LOGGING

Your FurnaceDoctor®-Pro is equipped with a built in memory data logging system. Data on all gas values is stored on 30-999 seconds intervals and is available for review from your PC on our Stand Alone chart viewer.

Data log data is stored on internally or on an industry standard USB memory stick.

File types are encrypted and are easily read by our Stand Alone chart viewer program.



Data saved will include time, date, Log Id, co, co_2, ch_4, and user entered temperature. Expected o2mv, dew point, %Carbon, will be determined in the “Configure I/R Screen”. The checked items will be data logged. (See Utilities)

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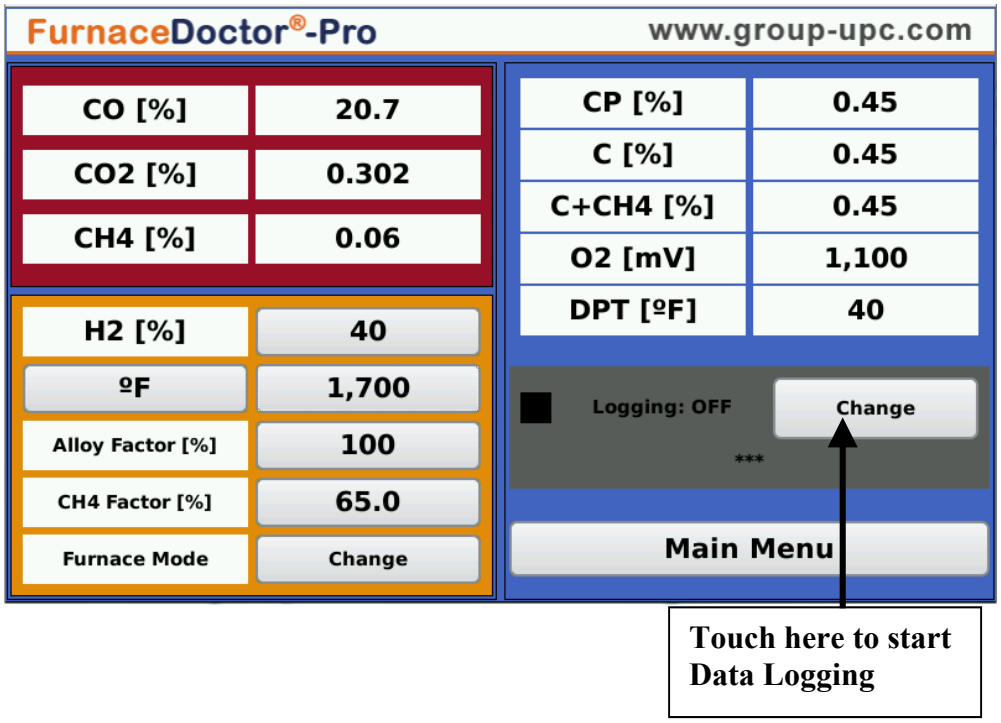
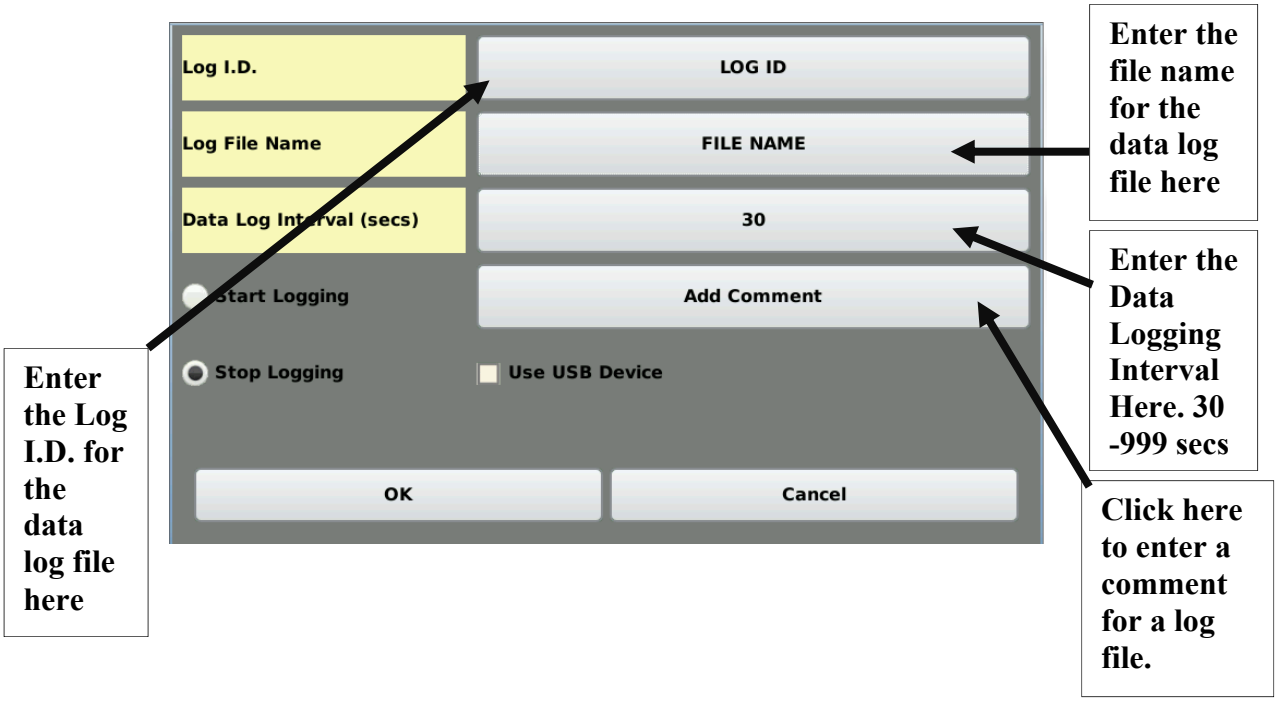
Starting the data logger:



Touch the *Change* button and this window will pop up


Log I.D.
LOG ID
Log File Name
FILE NAME
Data Log Interval (secs)
30
Start Logging
Add Comment
Stop Logging
Use USB Device
OK
Cancel
Enter the Log I.D. for the data log file here
Enter the file name for the data log file here
Enter the Data Logging Interval Here. 30 -999 secs
Click here to enter a comment for a log file.

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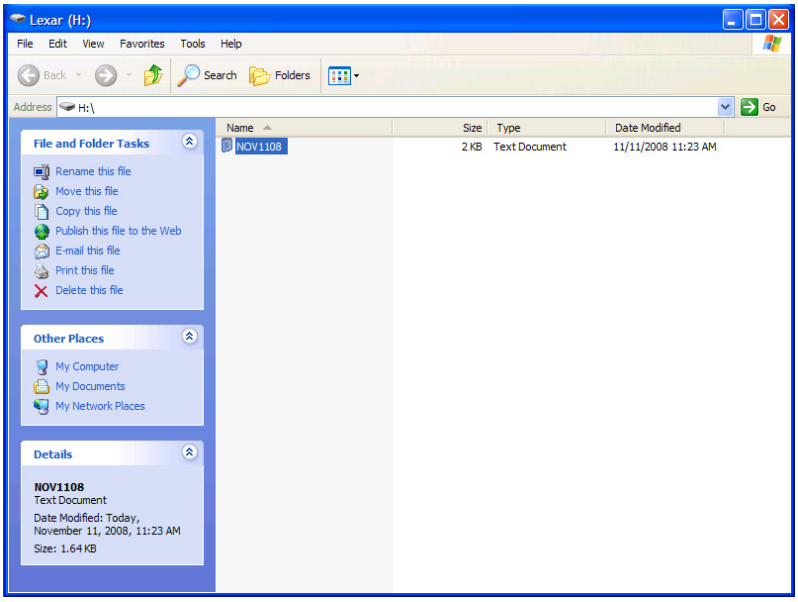
You must first enter a *Log I.D.* name for the file that will contain the data.

To enter the *Log I.D.* simply touch the filename field and the alpha numeric keyboard will appear.
The *Log I.D.* field allows you to enter a message that will be data logged with the I/R data.

For example you may name the log file May2109 for May 21st, 2009
Then in the *Log I.D.* field you type the furnace name. As you move from furnace to furnace you change the *Log I.D.* field.

The *logfile* assigns a name to the file. This is the name you will see when you insert the USB drive into your computer and open.



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Starting and Stopping Data logging:

To start data logging insert the USB flash drive in to the top of the FurnaceDoctor®-Pro.

Compatible USB FLASH Memory Sticks:

- Dane Electric (DA-ZMP-02G-CA-W1-R)
- PQI Mr. Flash U172 (Model # BB55-B1G3-0221)
- Corsair (Model # CMFUSBSF2.0-128)
- Viking Interworks (Model # USB00256L2)
- Kingston DataTravler (Model # DTI/1GBKR)
- PNY Technologies (Attache 256 or 512)
- Lexar JumpDrive
- Viking (Model # USB0032L)
- Sony (Model # Microvalt)
- Dell (Model # Memory Key)

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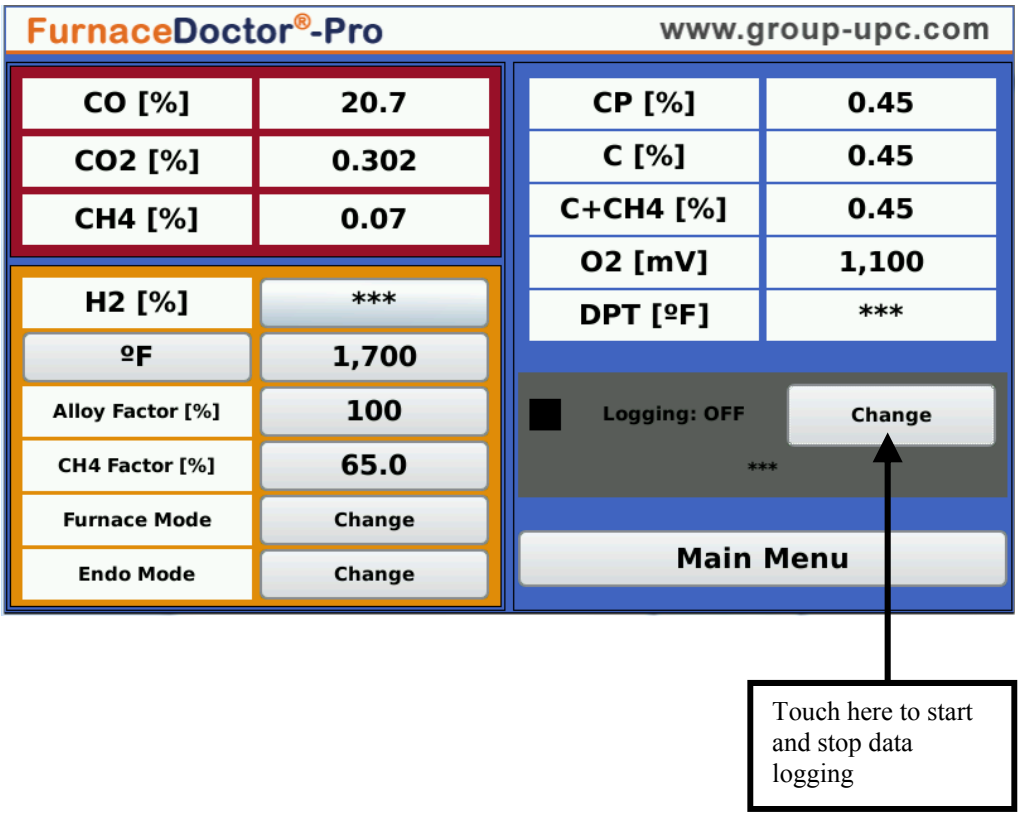
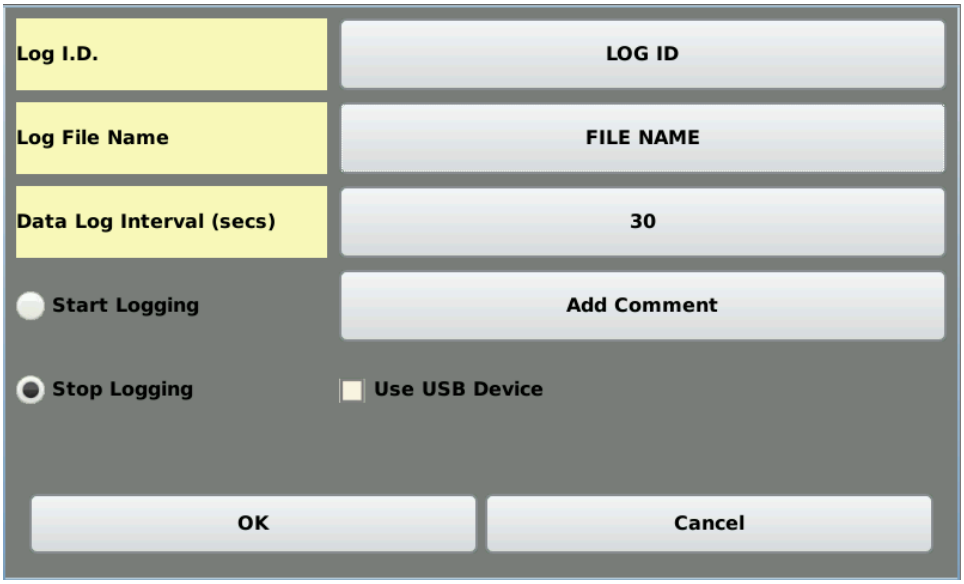
Touch the *Change* button next to the *LOGGING: OFF* text.



A window will pop up. Enter the *Log I.D., log file* name and *Data Log Interval* by touching the appropriate area. Touch the *Start Logging* button and touch *OK*.



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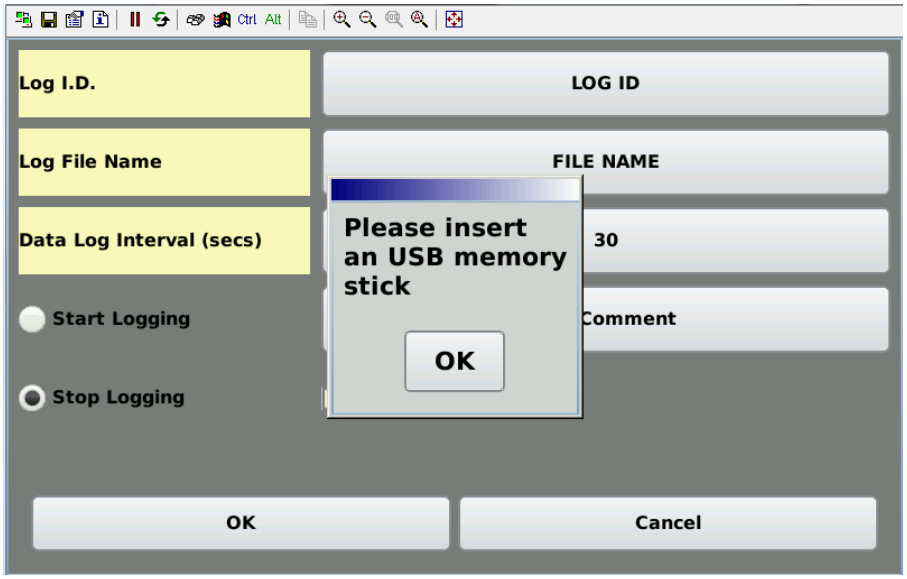
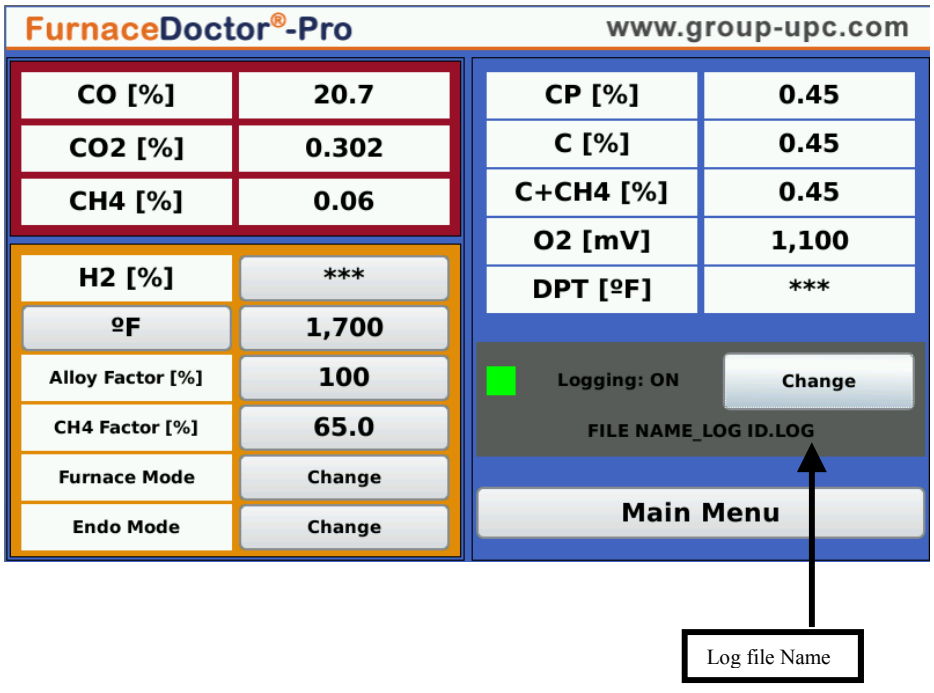
A window pops up stating *Please insert an USB memory stick*. Insert the USB stick and touch OK to start data logging.



After Touching OK the text next to the *Change* button will state *Logging: ON* and will display the *logfile* name in green.



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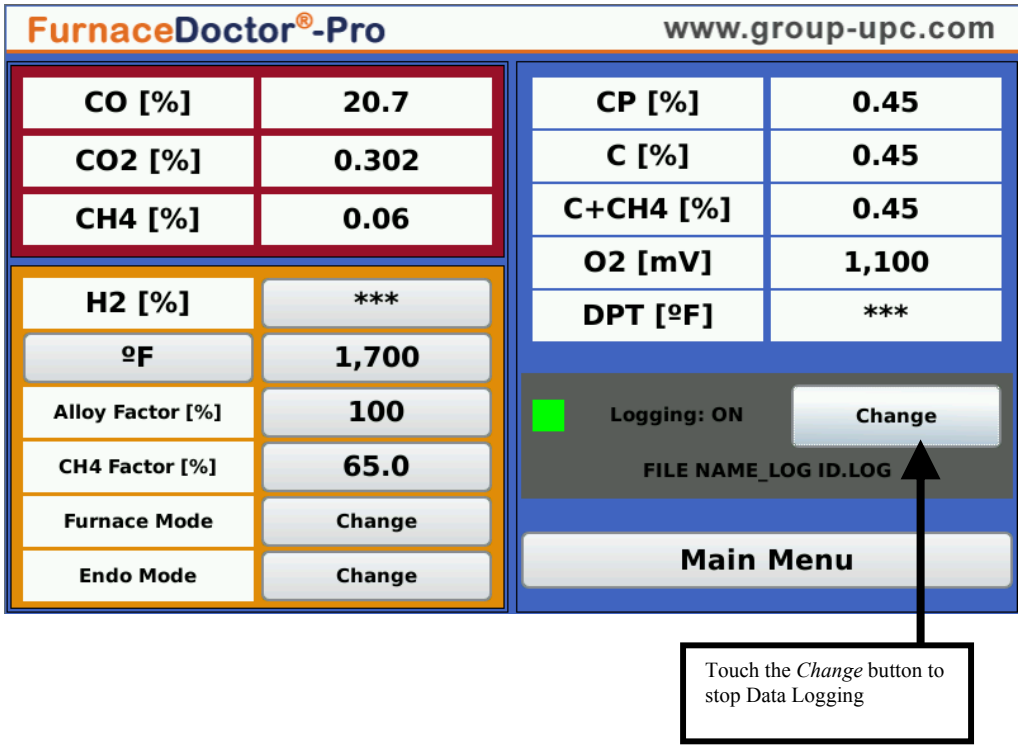
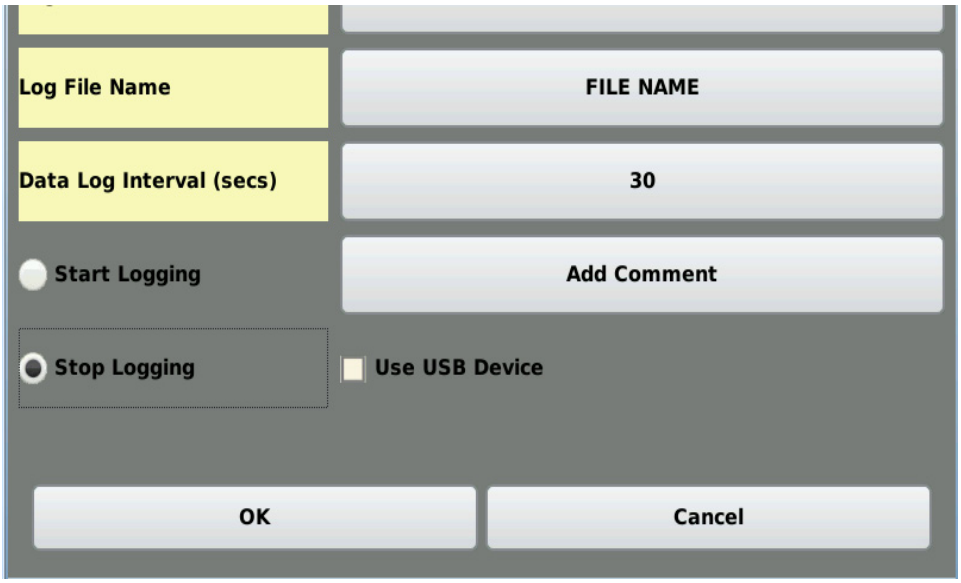
To stop Data Logging push the *Change* button.



You will see this screen. Touch on the *StopLogging* and then touch OK.



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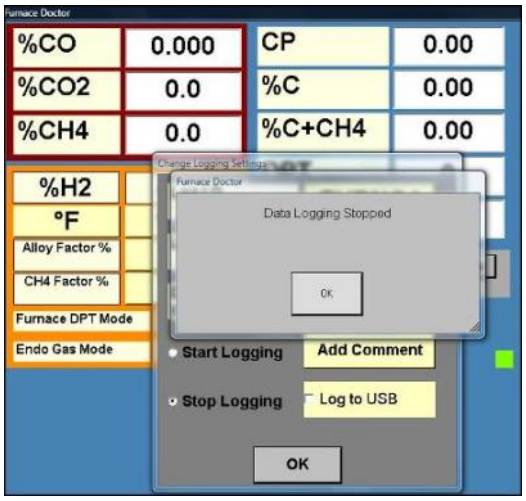
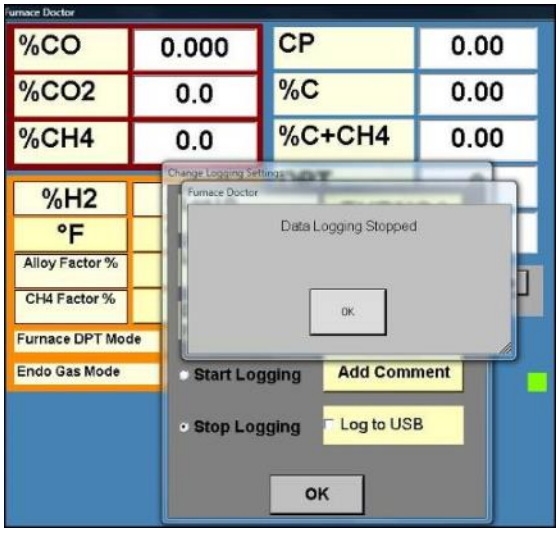
A window will pop up stating *Data Logging Stopped*



Touch OK and another window will pop up stating '*It is now safe to remove your USB memory stick*'.



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Press OK to acknowledge. Remove the USB drive and insert into your PC to read the data of the encrypted file on the standalone chart viewer.

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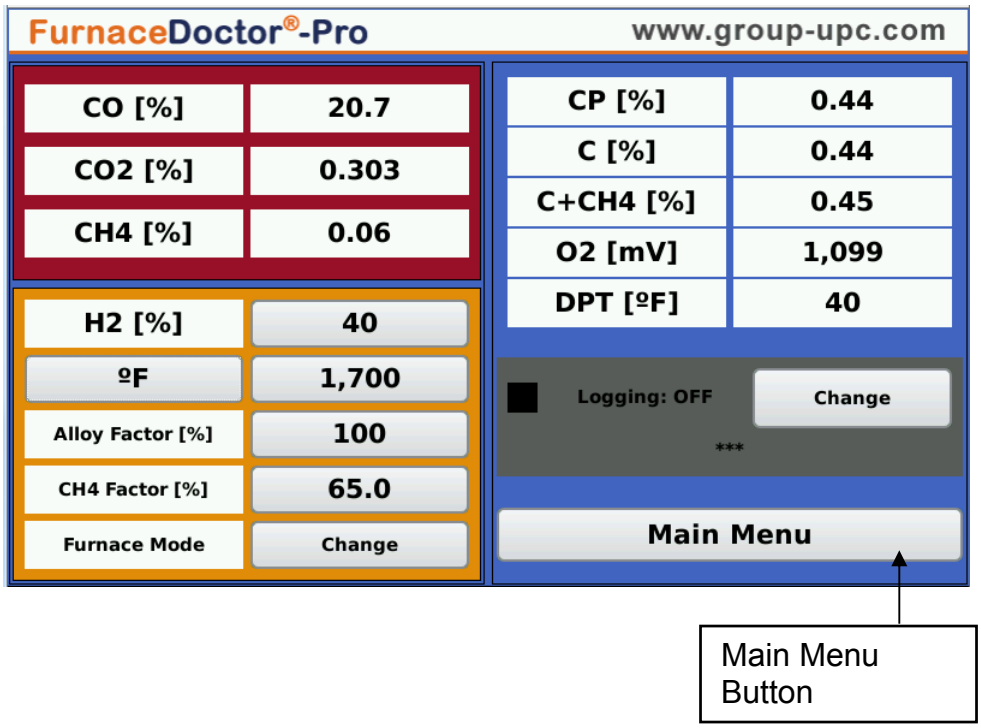
THE MENU SYSTEM



Touching the Main Menu button will take you to the system main menu.

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The following options are available on the main menu:

I/R Gas values – This is the display that you see when the instrument is first powered up. Data includes CO, CO_2, CH_4, and user entered temperature. Expected O2mv, dew point, %Carbon, will be determined in the "Configure I/R Screen" page 45. The checked items will be displayed and logged.

Utilities - This allows you to calibrate the touch screen, set the date and time, View internally stored data on a chart and configure the I*/R Gas Values* screen.

Proc Calc – Allows you to enter temperature, oxygen probe millivolts or CO, CO_2, CH4, H2, Alloy Factor, and CH4 Factor to compute carbon potential and dew point. You can also enter the dew point and temperature to compute the above.

Calibration – This option allows you to calibrate the instrument to certified grade gasses

About—tells about software version, customer support and the members of United Process Controls.

View chart – Allows the user to view internally stored data on a graphical chart.

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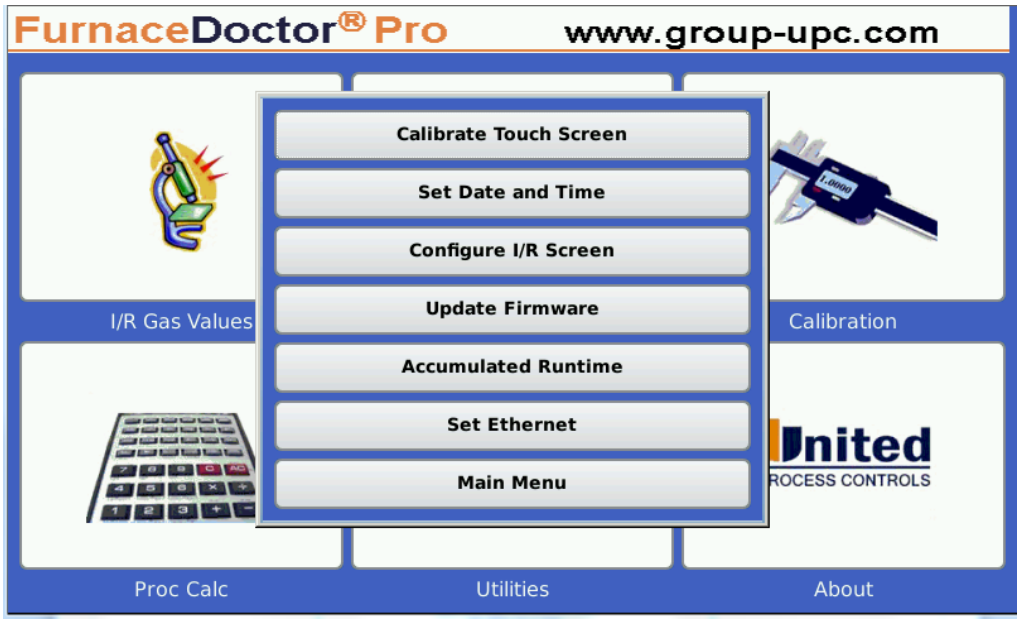
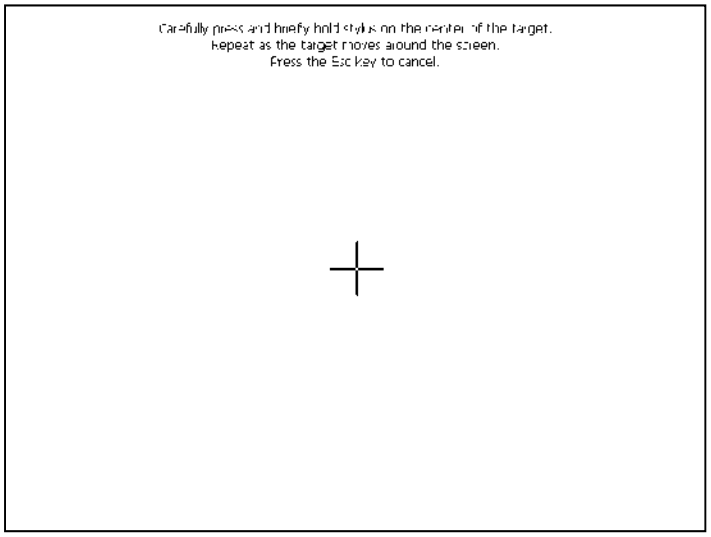
UTILITIES

Touch the desired option to select. A new window will pop up.



Calibrate Touch – Allows you to calibrate the touch positions on the screen by locating a target for you to touch at various positions on the screen.


Carefully press and briefly hold stylus on the center of the target.
Repeat as the target moves around the screen.
Press the Esc key to cancel.

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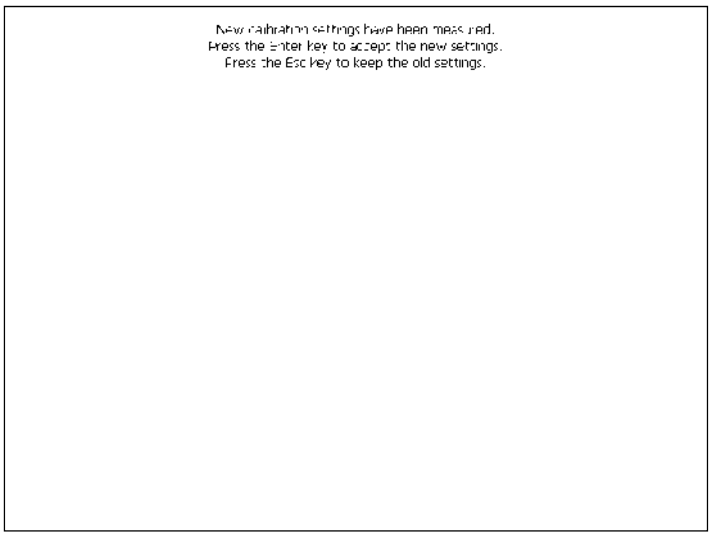
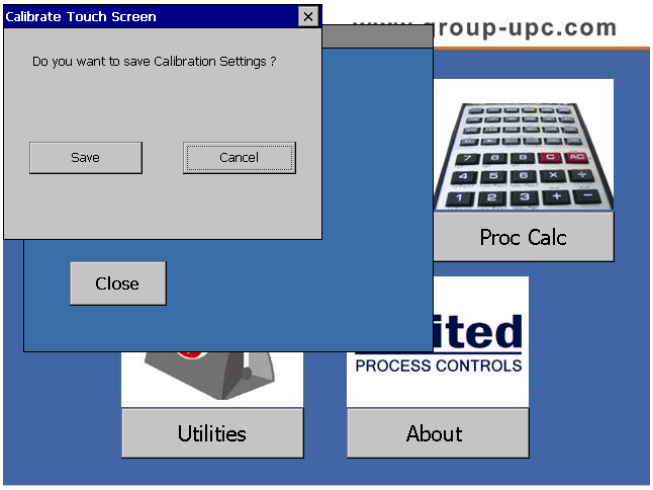
Follow the instructions to calibrate the touch screen. After completion of touch screen calibration the cross will disappear. It may take several tries. You will see this screen.


New calibration settings have been measured.
Press the Enter key to accept the new settings.
Press the Esc key to keep the old settings.

Touch anywhere on the screen to finish the touch screen calibration. You will then be prompted to save Calibration Settings.

Touch *Save*. You will then see this screen



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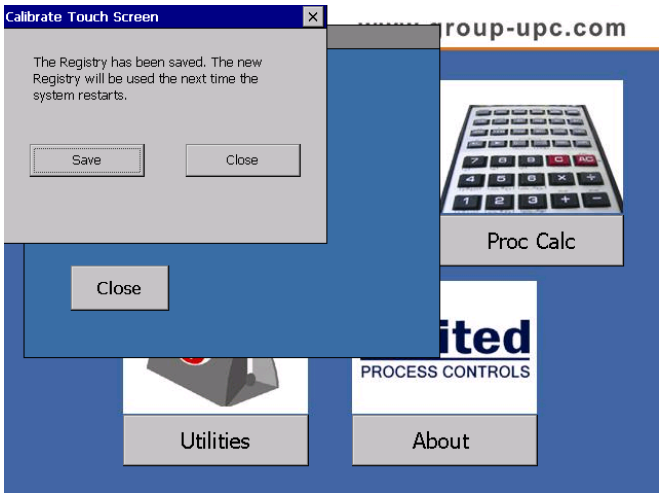

Touch *Close* and the touch screen calibration will be saved. The new setting will apply the next time the unit is turned back on.

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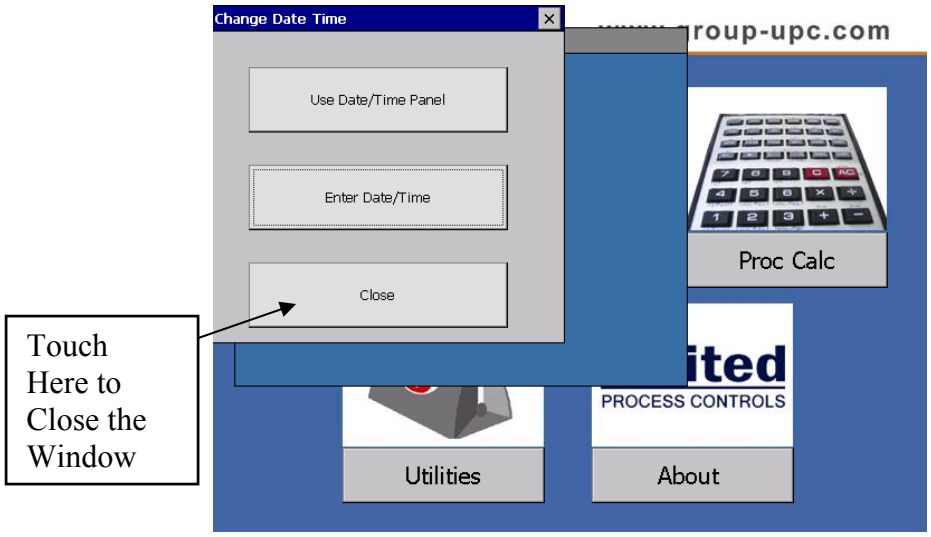
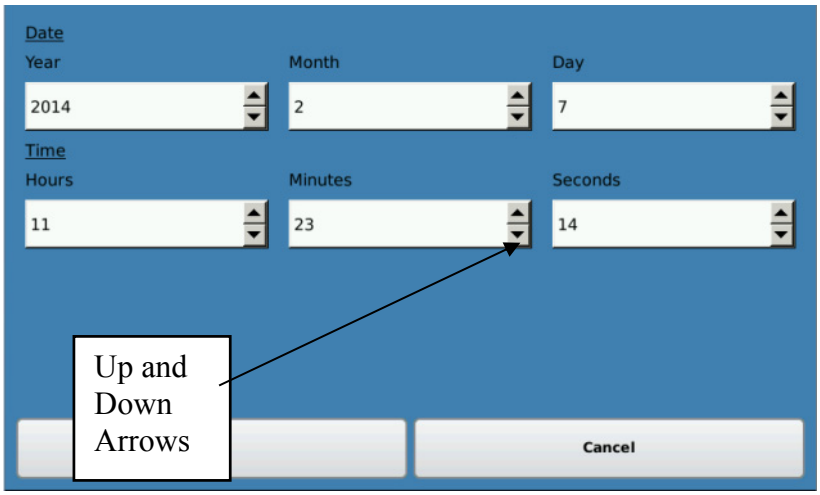
DATE AND TIME

Touch the *Set Date and Time* check box and the following screen will appear.



Touch on the *Enter Date/Time* button you will see this screen



Use the up and down arrows to change the Date and Time. After the correct date and time are entered touch the *Set Date / Time* button. The new Date and Time will then be saved

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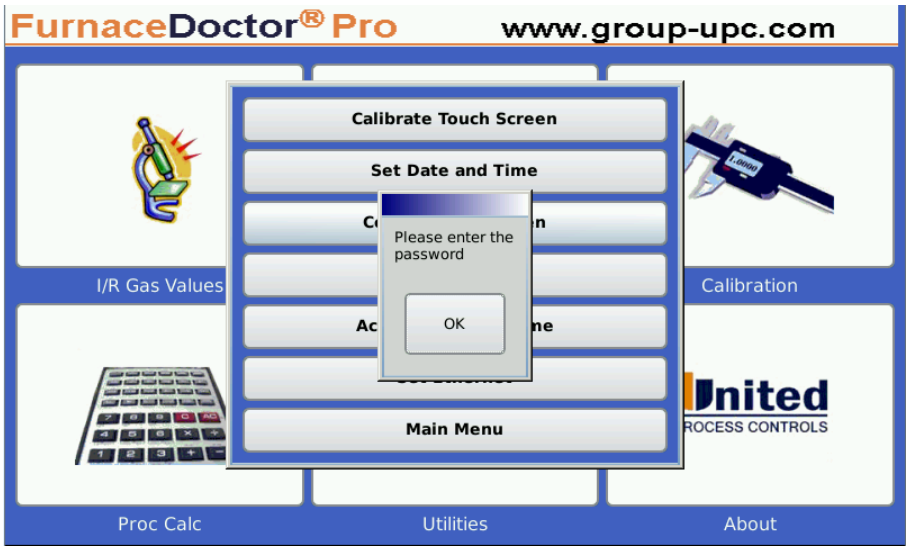
CONFIGURE THE IR SCREEN

This screen is for configuring the *I/R Gas Values* screen. Touch the *Configure I/R Screen* box.

A new window will pop up you will be asked for a password.



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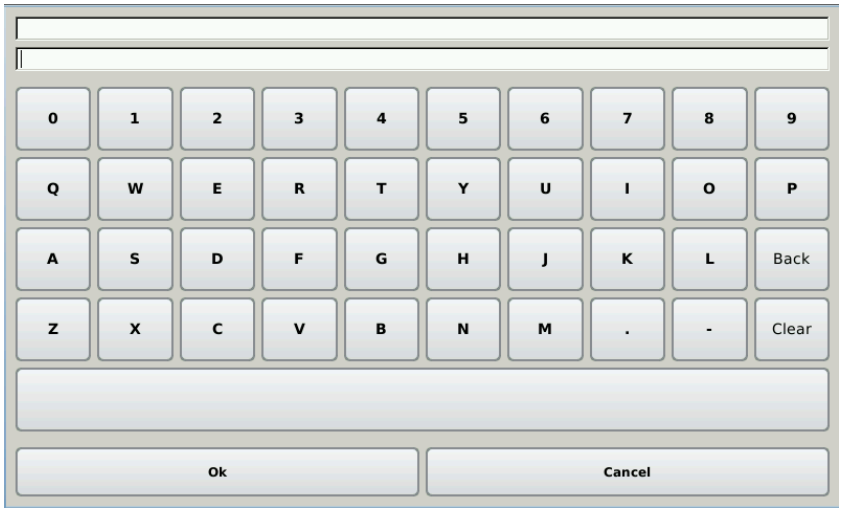
Touch *OK* and an alpha numeric keyboard will appear.
Enter the password and click *OK*.



Options include:

Show Atmosphere Carbon Potential -
This is displayed on the *I/R Gas Values screen* as *CP*. It is a carbon calculation that displays the carbon potential of the atmosphere using CO, CO2, and manually entered process temperature.

Show Steel Surface Carbon -
This is displayed on the *I/R Gas Values screen* as *%C*. It is a carbon calculation that displays the carbon potential of the steel surface using CO, CO2, and manually entered process temperature with the option of an *Alloy Factor*. The *Alloy Factor* is a process factor that can be determined by a shim stock test. The FurnaceDoctor®-Pro can then be adjusted to match you shim stock tests. 100 is nominal. Unchecking this option will invalidate the C+CH4 calculation.

Show CH4 Corrected Carbon Potential. -This is displayed on the *I/R Gas Values screen* as *%C + CH4*. It is a carbon calculation that displays the carbon potential of the atmosphere using CO, CO2, CH4, and manually entered process temperature with the option of a *CH4 Corrected Carbon Potential.* The *CH4 Corrected Carbon Potential* is a process factor that corrects for the catalytic effect that is happening in the furnace from free

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CH4. The *%c + CH4* box that will be displayed on the *I/R Gas Values* page will turn red if the furnace is not in equilibrium. 65 is the recommended default setting if you choose to use this feature.

Show O2 Probe Calculated Signal -
This is displayed on the *I/R Gas Values screen* as *O2MV*. It is a calculated O2 Probe millivolt using CO, CO2, and manually entered process temperature.

Show Calculated Dew Point -
This is displayed on the *I/R Gas Values screen* as *DPT*. It is a calculated Dew Point using CO, CO2, and manually entered process temperature and H2. There are 4 selections of carrier gasses available.

Nitrogen / Methanol which calculates the amount of H2 from the amount of CO that is present in the atmosphere to calculate dew point, and carbon potential.

Endo from Natural Gas which will use a 40% H2 to calculate dew point and carbon potential.

Endo from Propane which will use a 31% H2 to calculate dew point and carbon potential.

Gas Generators
Allows the user to select which type(s) of generator gas will be measured.

Other – Please specify H2 content which will use a manually entered H2 to calculate dew point.

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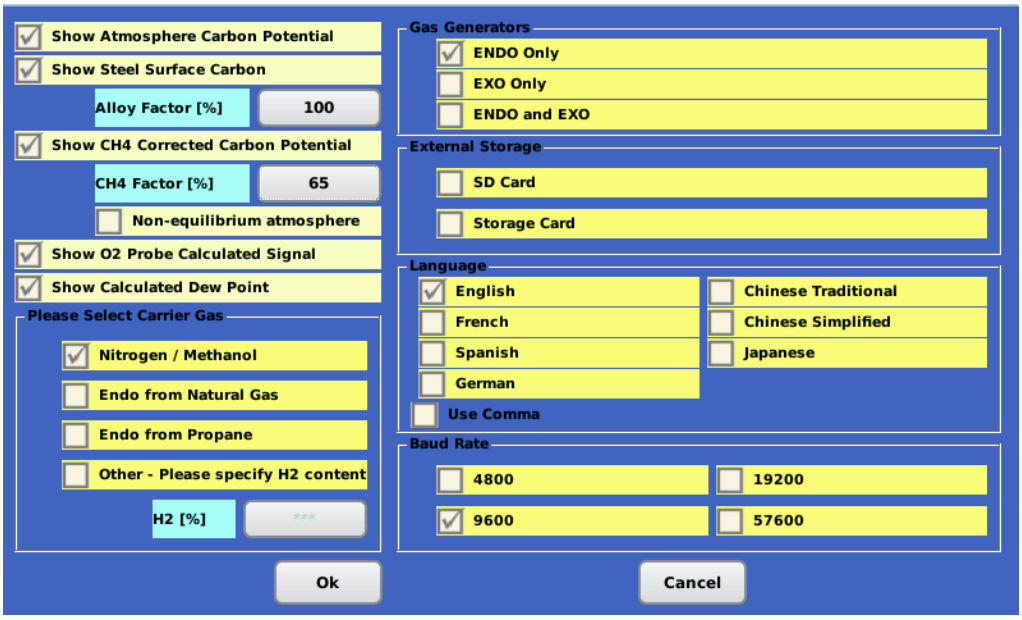
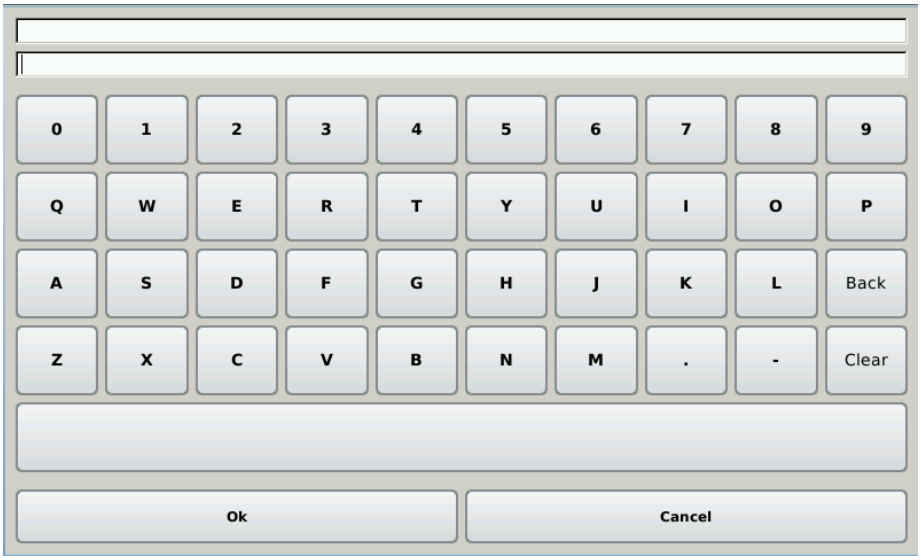


To Enter the *Alloy Factor %, CH4 Factor %*, and the *H2 %* for Dew Point and carbon potential calculations touch the corresponding box. An alpha numeric keyboard will appear to enter the value. Touch *OK* when done.



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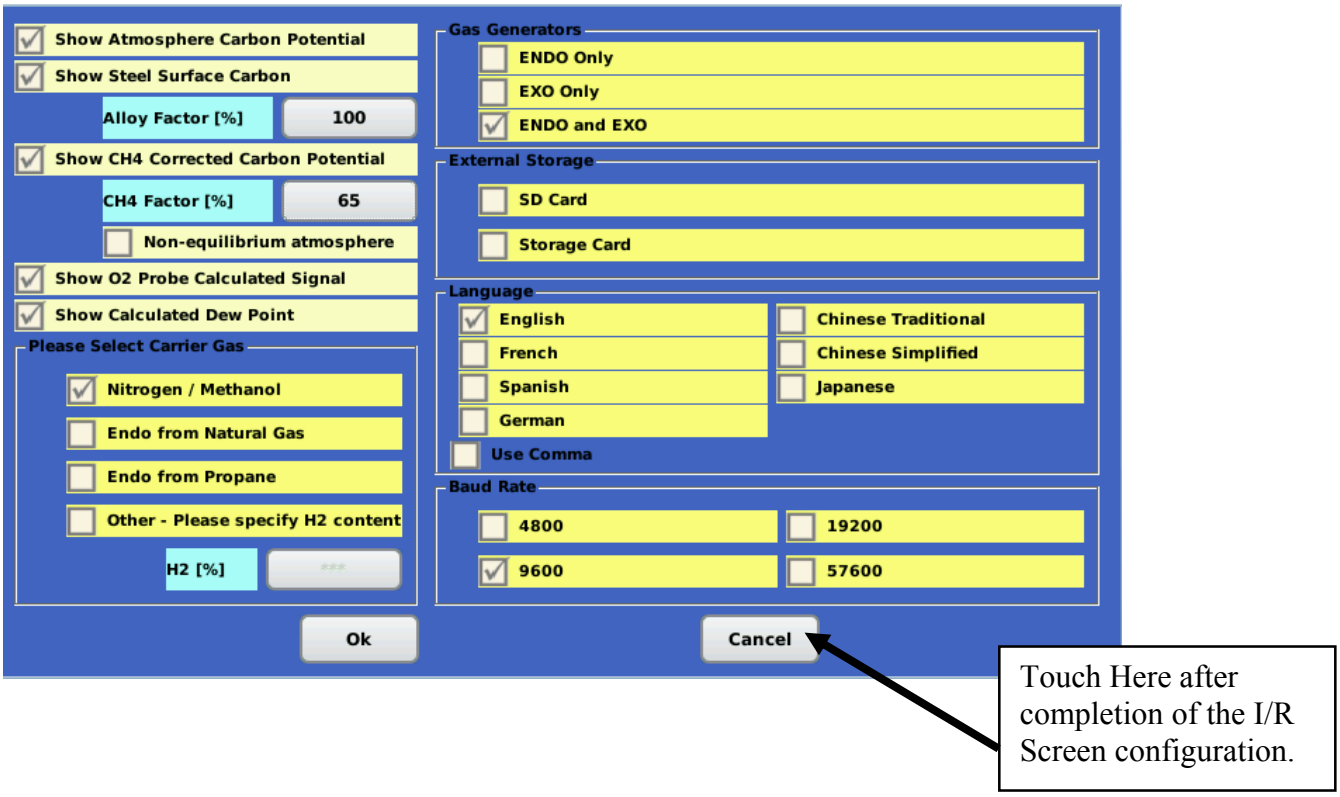
After you have configure the *I/R Screen* touch *OK* and you will be taken to the main menu. Cancel will discard any changes you have made.



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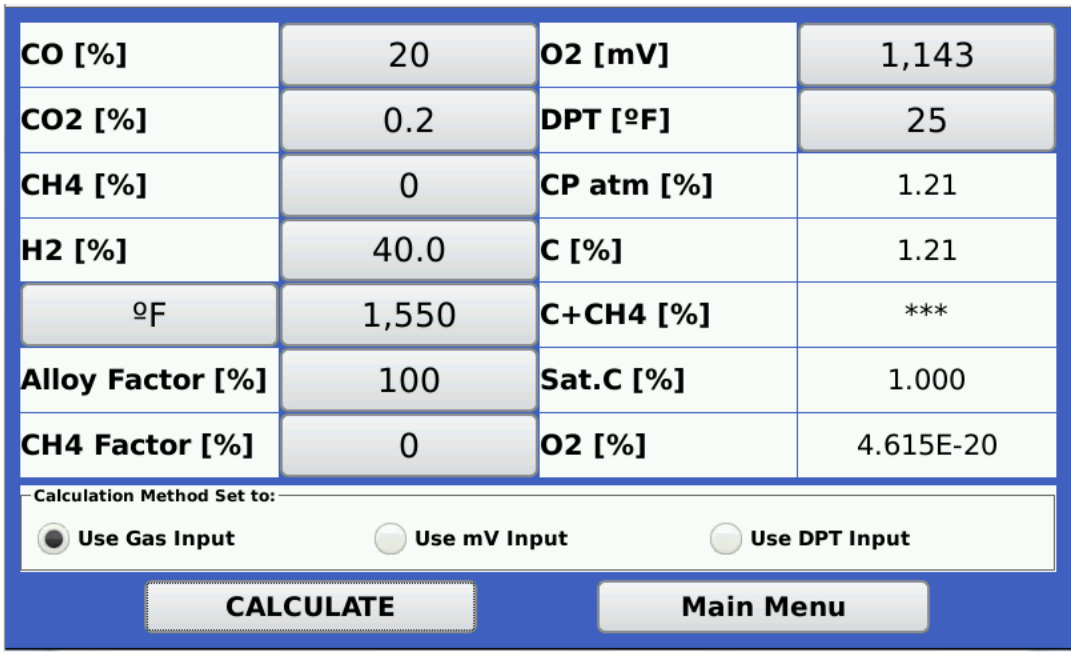
PROCESS CALCULATOR

This feature has several options for computing carbon potential, dew point, and probe millivolts. Input fields include %CO, the carbon monoxide percentage, %CO2, the carbon dioxide percentage, %CH4, the methane percentage, %H2, the hydrogen percentage, and °F or °C temperature. To change from °F to °C touching the °F button will change it to °C and vice versa.

Other inputs are O2MV, the carbon probe millivolts, DPT, the dew point, Alloy Factor [%], the Alloy Factor is a process factor that can be determined by a shim stock test. The FurnaceDoctor®-Pro can then be adjusted to match you shim stock tests. 100 is nominal, CH4 Factor [%], the CH4 Factor is a process factor that corrects for the catalytic effect that is happening in the furnace from free CH4. 0 turns this feature off.

Once an input percentage has been changed the CALCULATE button will turn red. Touch the CALCULATE button to calculate the changes.

To input a value touch on the appropriate input box.



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Options:

Use Gas Input
By entering the CO, CO2, CH4, Alloy Factor [%], CH4 Factor [%] and process temperature, the O2MV, DPT, CP atm, %C, %C+ch4, Sat. %C, and % Oxygen will be computed. Touch the CALCULATE button to calculate.

Use mV Input
By entering the oxygen probe millivolts, Alloy Factor [%], CH4 Factor [%] and process temperature, the DPT, CP atm, %C, %C+ch4, Sat. %C, and % Oxygen will be computed. CO2 is also calculated. Changing the % CO will calculate the %H2. This will change the calculated *DPT, CP atm, %C, and % C+ ch4*. Touch the *CALCULATE* button to calculate.

Use DPT Input
By entering the dew point (*DPT*), *Alloy Factor [%], CH4 Factor [%]* and process temperature the *O2MV, CP atm, %C, %C+ch4, Sat. %C,* and *% Oxygen* will be computed. *CO2* is also calculated. Changing the *%CO* will calculate the *%H2*. This will change the calculated*, O2MV, CP atm, %C, %C+ch4*. Touch the *CALCULATE* button to calculate.

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CALIBRATION

You may calibrate your unit with certified grade span gas, and nitrogen. If you have plant nitrogen available be sure to regulate it to approximately 1 PSI. Span bottle gas must have a bottle top regulator that will be capable or regulation at 1 PSI. ***Be sure that your gas supplier provides you with a certified analysis of the gas in the bottle!***
You may purchase span gas bottles from Furnace Control Corp. Please contact your local Furnace Control Corp representative.

Values for span gas should be 20- 25.0%CO .7-1.0%CO_2, and 8-15.0% CH_4 and 40% H2 with the balance of nitrogen. It is recommended that you select span gas with values approximately 20% higher than typical observed process value. Span gas values may be higher, or lower, but should not exceed the ranges of the measuring cells of 30%CO, 2%CO_2, and 15% CH_4.

Be sure to keep the second stage regulator pressure around 1-2 PSI. Your FurnaceDoctor®-Pro is equipped with good internal pressure regulation, but too much pressure may override the regulator's ability to control the pressure in the cells.

It is important to understand the I/R cells are very pressure sensitive by nature. Realize that for a given species of gas there are more molecules of that gas present in a cell with a pressure of 1.5 PSI., than in a cell with a cell pressure of .5 PSI. This will lead to measurement error if the unit is calibrated at a high pressure, and then applied to low pressure measurements.

You may observe this phenomenon by closing of the exhaust of the instrument while measuring a furnace. Note the quick rise in the CO value.

Calibration:
Furnace Control Corp recommends the following procedure:

Connect the span bottle to the instrument and measure it on a weekly basis. If the instrument measures the span bottle within 2% of the analyzed values on the bottle it is not necessary to calibrate the instrument.

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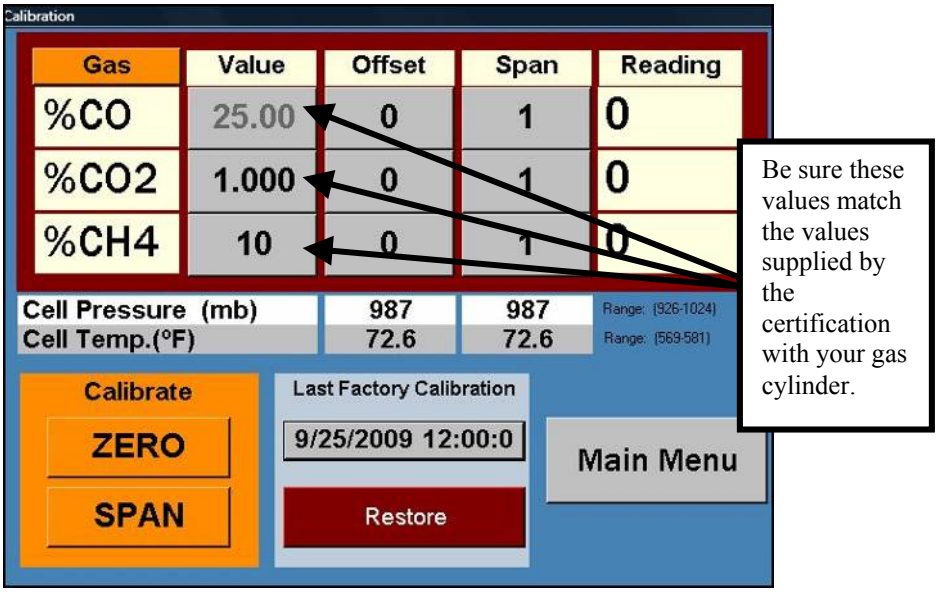
If calibration is required do it in the environment that the instrument will be used in. If you calibrate the instrument in an office that is 70 degrees, and then go use the instrument in a 110 degree heat treat, you will probably experience some error in measurement.

To begin calibration:
The procedure for Span gas values only needs to be performed when a new span bottle is to be used.
Touch the *Main Menu* button from the main screen then the *Calibration* button to get to the calibration page. Be sure that the span gas values on the calibration page match the certified gas values provided with the span gas bottle.



If these values need to be changed touch the appropriate field and enter the new value from the cylinder certification.

The offset and span values will be computed automatically during calibration. The Reading fields are the actual measured values.

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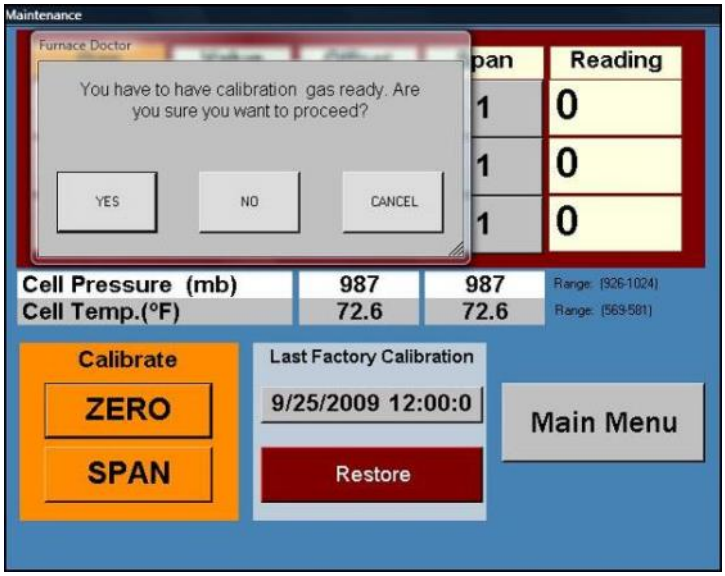
Starting Calibration:

Connect and turn on the nitrogen gas. Be sure that you have adequate flow, and touch the *Zero* button. The following screen will appear:



Touch ***Yes*** on the dialog box or touch *CANCEL* or *NO* to cancel the calibration.

After *YES* is pressed you will see this screen

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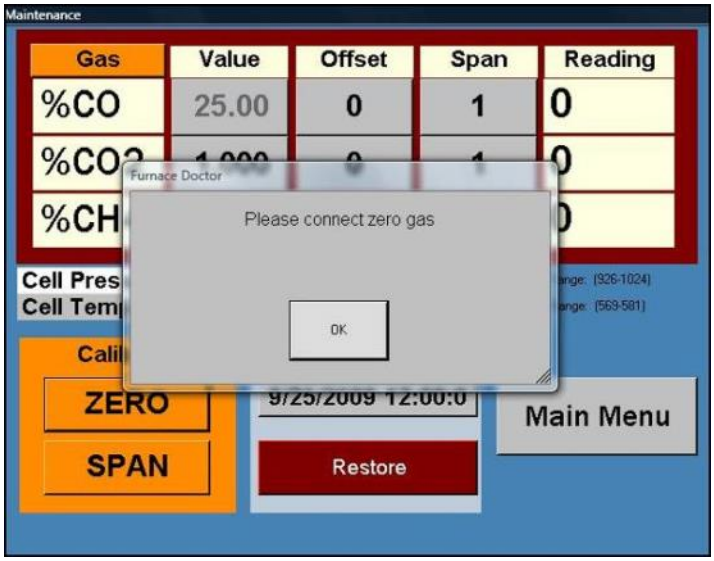
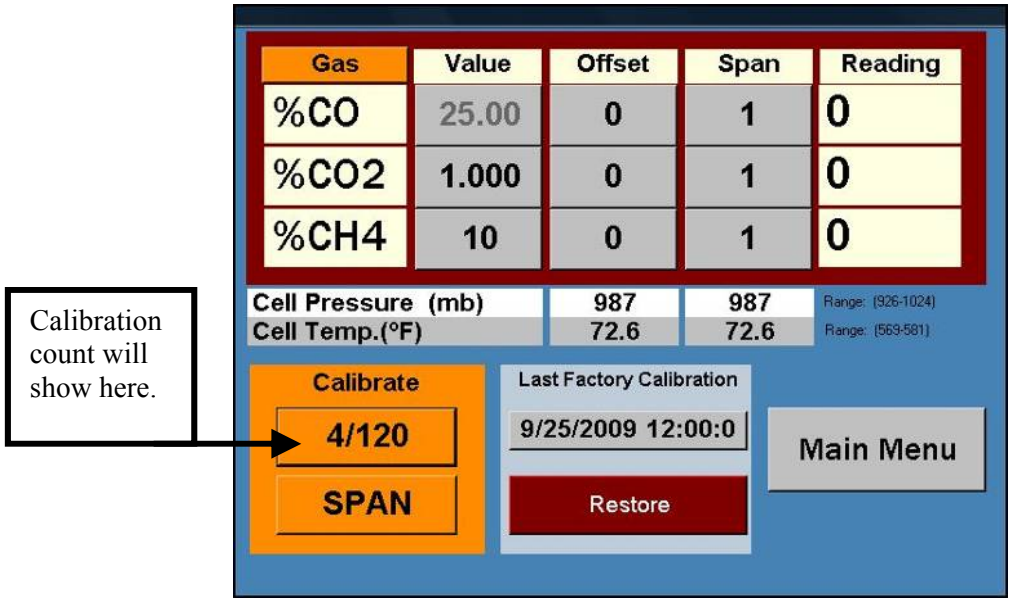


After nitrogen has been connected and there is adequate flow press *OK* to start the calibration.



The FurnaceDoctor®-Pro will count up to 120. When it has reached 120, connect and turn on the span gas. Be sure that you have adequate flow, and touch the *Span.* button. The following screen will appear:

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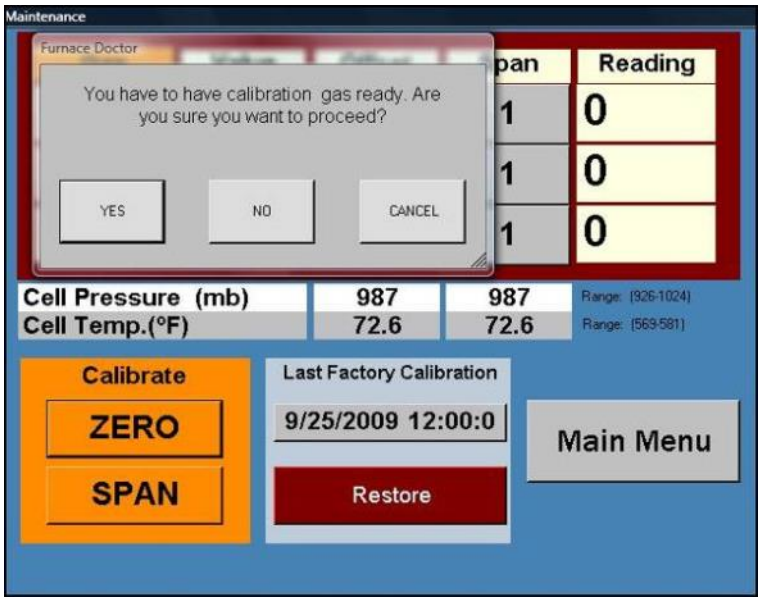
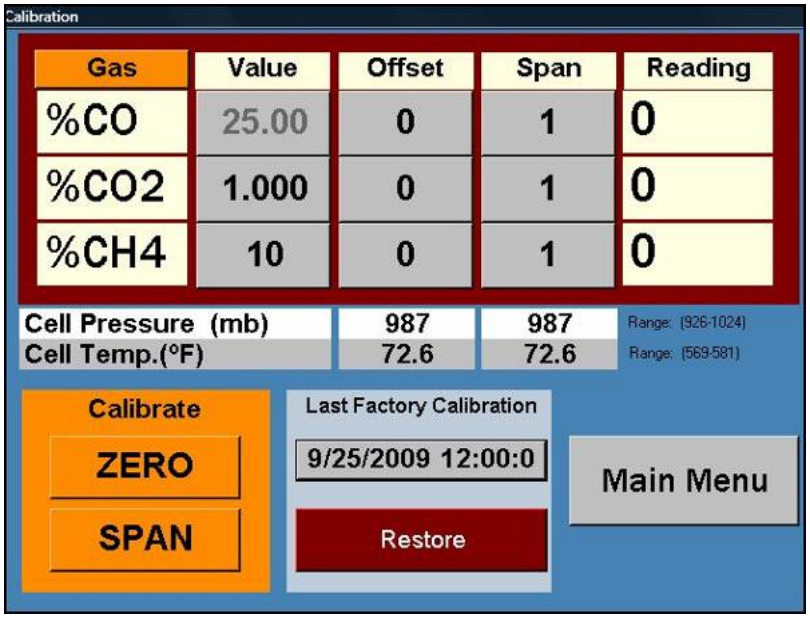


Connect and turn on the span gas, be sure that you have adequate flow, and touch *OK* on the dialog box.

Follow the same procedure as Zero calibration.



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Once the unit has counted up to 120 the calibration is complete. You can now return to the *I/R Gas Values* screen. The instrument should read the values in the bottle within 2% of the cell range. (I.e. 30% CO should be +/- .6% CO.)

Annual ***Factory Calibration*** is suggested. Retain original box and custom packing foam for return shipment to FCC. Annual factory calibration will ensure your analyzer performs at a high degree of accuracy throughout its life.

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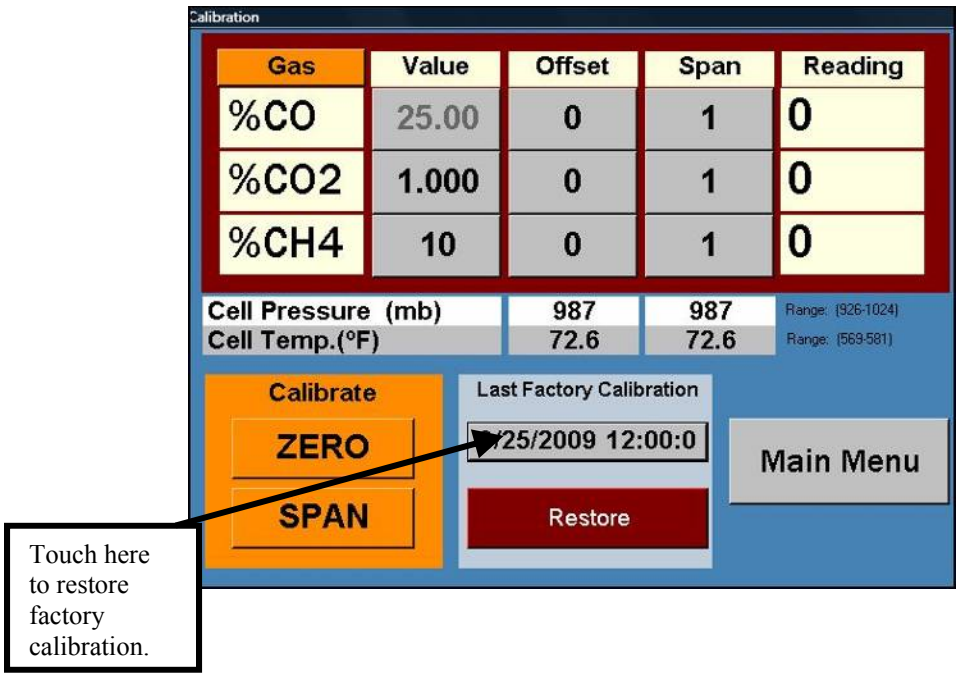
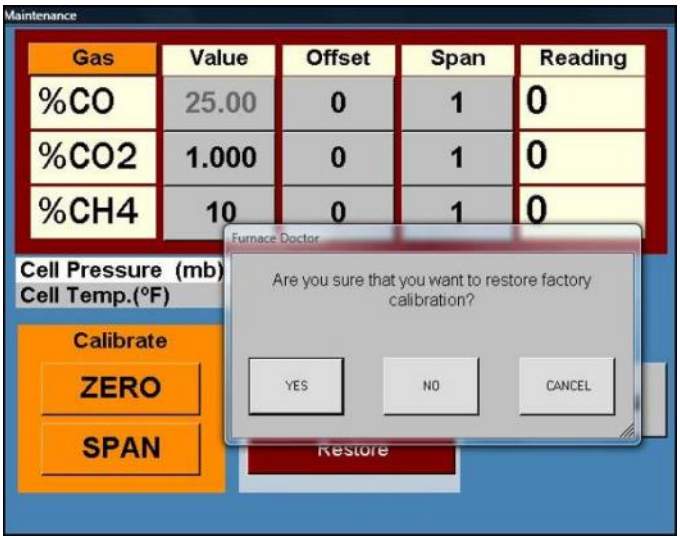
RESTORING FACTORY CALIBRATION

If you wish to restore the calibration performed at the factory then touch the *Restore Factory Cal.* button.



You will be prompted with *Are You Sure you want to restore factory calibration*? Touch *OK* on the dialog box and the last factory calibration data will be restored



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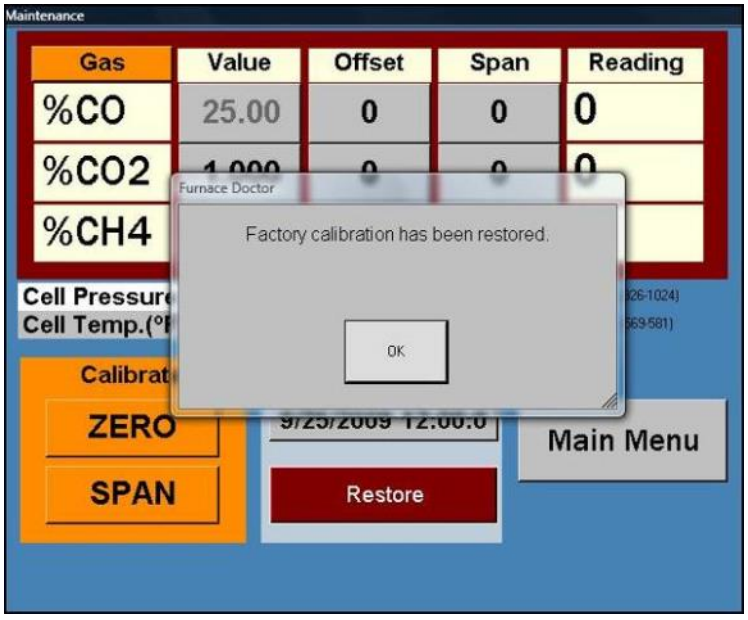
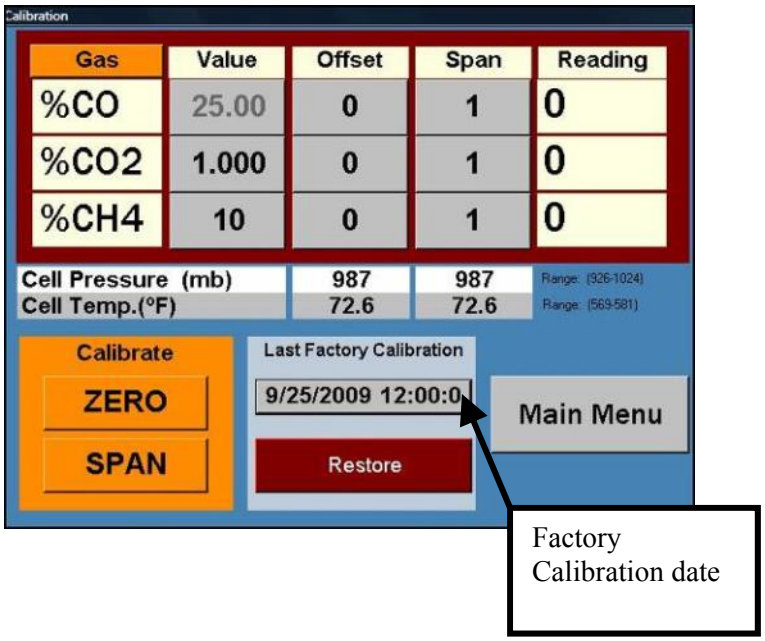
You will see this screen next. Touch *YES* to complete the restoration of factory calibration.



Factory Calibration Data:



When you send your analyzer into Furnace Control Corp. for calibration, the calibration data, and the factory calibration date are entered and stored in the analyzer's memory by the use of a password.

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BATTERY CHARGER

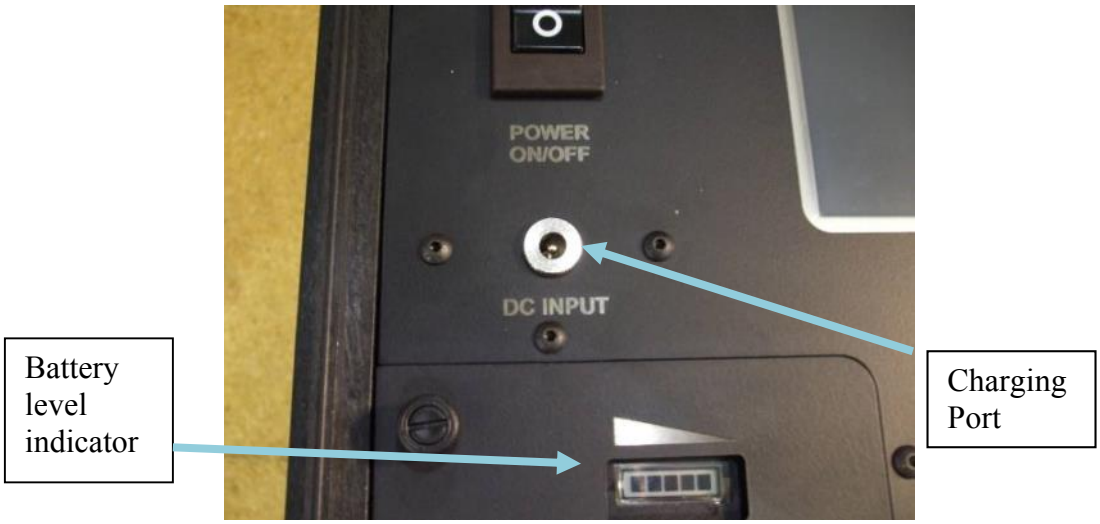
Your FurnaceDoctor®-Pro includes a battery charger **-** universal A/C adaptor.

Charging

Unit will operate continuously for approximately 6 hours without recharging. A full charge will take approximately 2 hours to complete. It is not necessary to completely discharge the battery before charging.

To charge the unit -

Connect the supplied
Battery charger - universal A/C adaptor into the D/C input port on the top of the Furnace Dr.



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Note: Unit is designed to operate with a charged battery or with the A/C adaptor. Using the charger as an AC adapter will not allow the battery to charge as quickly as it would otherwise. It is a best practice to connect the charger with the unit's power off and fully charge the battery. The unit will not operate with the battery removed.

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ETHERNET SETUP

You can access the VNC server using the Ethernet port.

To access the Set Ethernet button you can start by navigating to the Utilities Menu.

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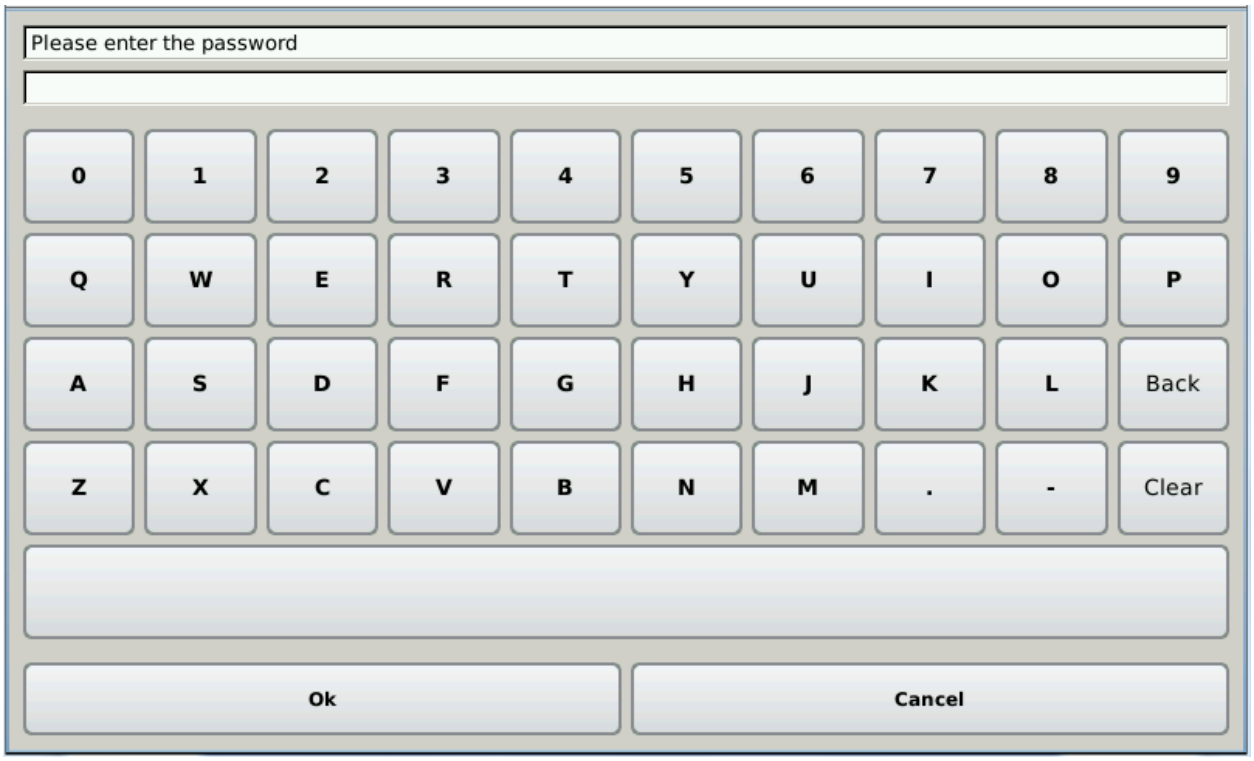

Password for this screen is 0401. Contact your local network administrator for setup information to use this interface properly on your internal network.

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VNC VEIWER

TightVNC viewer software comes with your FDPRO on the included Flash drive.

What is TightVNC?

TightVNC is a free remote control software package. With TightVNC, you can see the desktop of a remote machine and control it with your local mouse and keyboard, just like you would do it sitting in the front of that computer. TightVNC is:

- useful in administration, tech support, education, and for many other purposes,
- cross-platform, available for Windows and Unix, with Java client included,
- Compatible with standard VNC software, conforming to RFB protocol specifications.

Install TightVnc on your local machine.

Running TightVNC Viewer:

To view and control a remote desktop where a TightVNC Server is running, you need to run the TightVNC Viewer.

To run the viewer, choose:
Start->Programs->TightVNC->TightVNC Viewer.

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You will see a window allowing choosing a server to connect to

New TightVNC Connection
Connection
Remote Host:
192.168.36.11:5900
Connect
Enter a name or an IP address. To specify a port number, append it after two colons (for example, mypc::5902).
Options...
Reverse Connections
Listening mode allows people to attach your viewer to their desktops. Viewer will wait for incoming connections.
Listening mode
TightVNC Viewer
TightVNC is cross-platform remote control software.
Its source code is available to everyone, either freely (GNU GPL license) or commercially (with no GPL restrictions).
Version info...
Licensing
Configure...

To connect to remote server, enter its host name or IP address in the field "Remote Host" and click “Connect". Port number is optional; you need to specify it only if it differs from the default value (5900).

TightVNC files	Location
Default destination	Program Files\TightVNC
"Start" menu entry	Start->Programs->TightVNC
Registry keys	HKEY_LOCAL_MACHINE\Software\TightVNC HKEY_CURRENT_USER\Software\TightVNC

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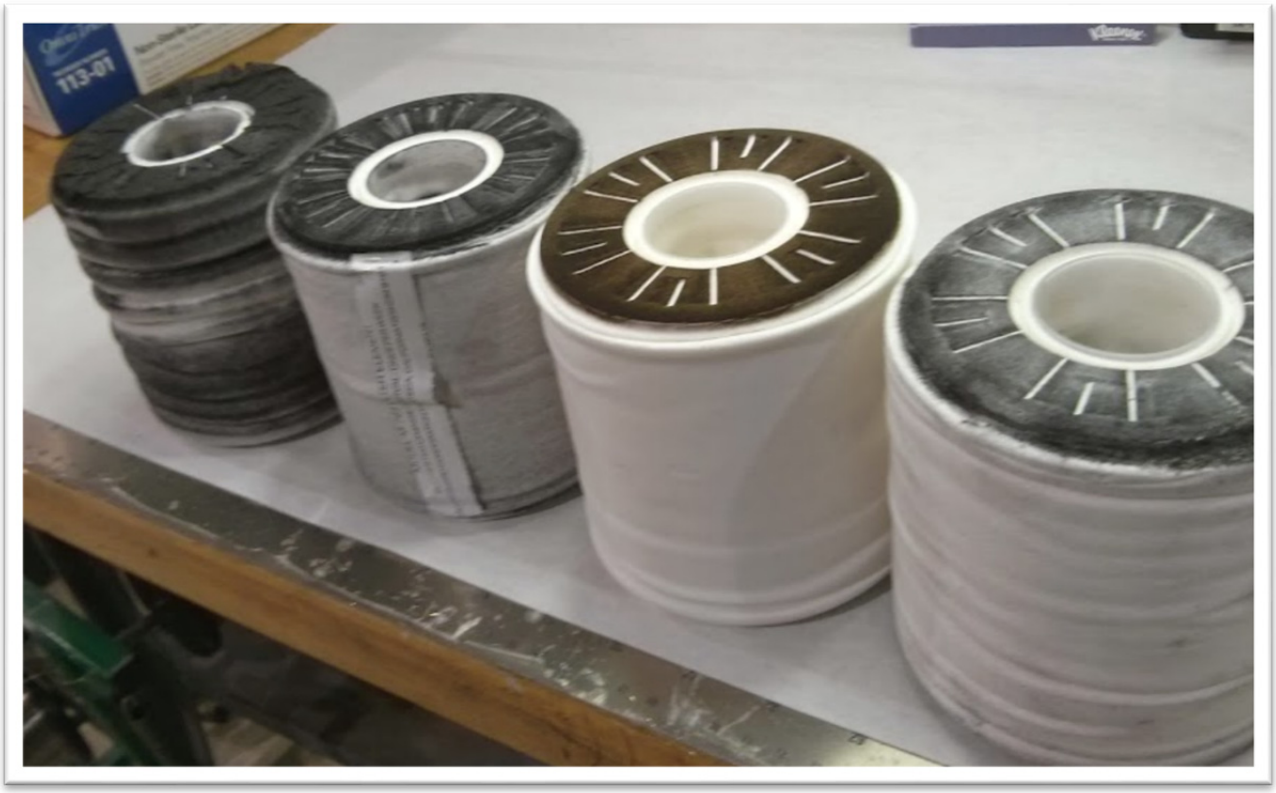
FILTER MAINTENANCE

4 filters with various rates of use – all 4 should be changed, the filter bowl cleaned out and new filter element installed.



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This is typical use after a few months.
This filter is starting to get soot buildup and should be changed before use again.

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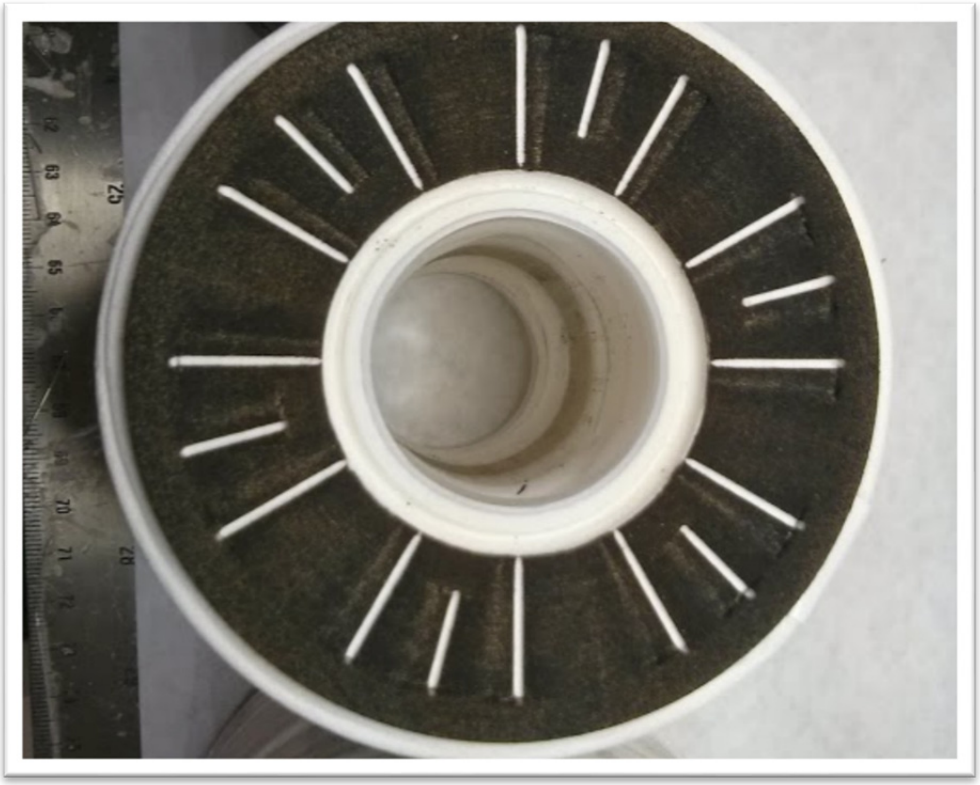

This filter used with dirty natural gas, notice the yellowish tint.
A filter looking like this should be replaced with a clean filter.

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This filter has been taken out and re-inserted (not recommended)
Notice the multitude of additional indentations in the top.
This filter is past due for replacement.

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This filter is in horrible condition and is way overdue for replacement.

This filter cannot do its job properly any longer and contamination has resulted (very costly).

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SPARE PARTS

Replacement Battery	-	T-LITHIUM-BATTERY
Desktop Battery Charger	-	T-LITHIUM-SMARTCHARGER
Filter Element	-	T-FIL-04
Filter Housing	-	T-FIL-03E
Extra Tubing	-	T-REDTUBE (qty. in feet)
Portable Battery Charger	-	T-AC-ADAPTOR
Barb Adaptor (for tubing)	-	T-AD1-TU-BA-0.25

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United Process Controls brings together leading brands to the heat treating industry including Waukee Engineering, Furnace Control, Marathon Monitors and Process-Electronic.
We provide prime control solutions through our worldwide sales and services network with easy-to-access local support.

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